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Living territories to transform the world

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Foreword

If the 'territory' – in its broader sense of the French *territoire* – is the answer, what is the question? Why do we need to reshape the frameworks for governance we've inherited for living together on this planet? How would a stronger 'territorial' focus help us achieve more sustainable models of development as envisaged by the ambitious aspirations of the Paris Climate Accord and the Sustainable Development Goals? I can think of four good reasons which resonate with the arguments outlined in this timely volume.

First, to rebalance power. Too much power and too many resources have been sucked out of local economic circuits, sapping communities of the capital, people, and ideas needed to maintain a viable livelihood. We have not managed well the tensions between the growth in output and incomes promised by globalization, and its inevitable backwash which has churned up the societies, values and hopes of those on the wrong side of market forces. The highly uneven gains and losses from massive investment flows and extensive global supply chains have seen no counterpart in public action to buffer the damage and offer support. Governments individually have been unwilling to take on the unrivalled power now held by mega-corporations, and have refused to insist on payments to the public purse, which could help recompense the losers. As I write this in late 2016, the consequences of market ideology unchecked by social constraint have been made most painfully evident by the Brexit referendum result in the UK and the election of a populist President in the USA. With too many people sensing they've been left behind, a rallying cry of 'Take back control!' seems to offer a remedy. A more promising approach, using the territory as an architectural basis, helps establish an arena in which people feel connected to structures of power, and can see that it is possible to get things done. The territorial approach re-establishes a sense of agency and local citizenship, in contrast to national-level government, which has become both too complex and difficult, but also seemingly powerless in the face of larger global forces, conflict, and upheaval. If we did more things locally, we would help unravel some of the complexity at the national level.

Second, to build better and more resilient connections between institutions and ecological resources. All too often, vital ecological resources are split by administrative boundaries which make nonsense of the natural landscape. This is especially the case with rivers and wider watersheds, where the geographic integrity of the river basin is rarely matched by an administrative system with the powers required to manage upstream-downstream interactions. In poor and rich countries, many people have seen the impact of unexpected and devastating floods on their homes and farms,

on their cities and settlements. Climate change has led to more volatile rainfall, with extraordinary amounts of rain falling in a rapid period. In the village in central Mali where I am doing research, in mid-August 2016, 110 mm of rain fell in five hours, so that people were wading through waist-high water, and many of their mud-brick houses fell down. And back home in the UK, in December 2015, more than 340 mm fell over a 24-hour period in the north-west of England. It is very difficult to cope with such intense downpours, but pursuing a territorial approach would at least make it easier to plan land use in ways that limit future flood risk.

Third, to celebrate identity. If you take the high road from Penrith to Barnard Castle, you travel through the uplands of north-west England, with their characteristic windswept fells of rough grazing, criss-crossed by dry stone walls, snaking their way across the landscape. Each cluster of stone farmhouses and barns gives tangible expression to the cultural traditions of the western Pennine mountain territory. Whether you're in the Pennines, in the wide savannahs of Maasailand in eastern Africa, the high Andean mountain terraces of Peru and Bolivia, or amongst the stout white and red manor houses in the valleys and hills of Basque country in the Spanish Pyrenees, there's a sense of pride in common identity and heritage, as well as in shared struggles against hard times. This strength of rural solidarity is not surprising, since it is less than ten years ago that world population swung from being predominantly rural to urban. It can be no accident that, as global economic forces have become ever stronger, interest in local culture, identity and dialect has also strengthened greatly. As people, we often forget our animal heritage, but whether we like it or not, the role of territory and tribe remain hugely important, as a source of identity, and as means to determine who's in and who's out of the group. Somehow we need to build on the positive aspects of rootedness, identity and cultural traditions, and moderate those impulses on the other side of the coin which can be too easily harnessed to target 'the other'.

Fourth, to re-establish the urban-rural nexus. Compare the 1950 map of West Africa with that for 2010, and you can see the extraordinary mushrooming of small towns which has taken place across the region. While capital cities have also expanded, the most striking feature of the map is the way that hundreds of small towns have sprung up in rural areas. These towns have massive impacts on neighbouring landscapes and livelihoods, generating multiple flows of people, goods, services, money and ideas between small and large settlements, local and municipal market places, and businesses in town and village shops. Getting the best from these urban-rural links needs to be at the heart of a territorial approach.

So there are many strong reasons why the territory should be the foundation stone for constructing a more sustainable planet. None of the Sustainable Development Goals will be achieved without engaging in the design and implementation of local actions. It's not the only building block, since a bottom-up process needs to meet a top-down set of public policies that interlock with each other. It's like an architect and builder working together. Success in achieving an ecological transition will need ambitious public investment in common resources, such as the institutions

and infrastructure that support a low-carbon transition[1]. As with common property resources, a territorial approach has to be nested in a set of hierarchies, inter-related and operating at different scales.

The term 'territory' is necessarily imprecise, since the exact scale or geographical space depends on the purpose chosen. We live in a less-than-ideal world, so pragmatism is important to identify the lowest scale at which we can achieve many of the goals sought. As an Anglo-Saxon, the term 'territory' risks misunderstandings, but I take it to mean 'a geographical space as appropriated and perceived by individual or collective actors' (Chapter 33 of this volume), rather than the much more limited meaning it normally has in English, describing an area fought for and protected by an animal, bird, or conquering power.

As contributions to this volume show clearly, if the territory is to have any force in making decisions and taking action, it needs to be equipped with power and resources. The decentralization process followed in many low income countries since the 1990s shows that local government is seriously hampered when few if any powers are transferred. They may have significant responsibilities but, without some financial autonomy – such as local levies, control over land use, a tax on key resources –, the promise of decentralized governance risks being an empty shell, hollowed out by higher-level government preferring political advantage above a practical response. Defining the boundaries of what constitutes a territory needs to take into account the need for a viable fiscal system. Reliance on funds from national government perpetuates central control, and makes local government highly vulnerable to political swings. Somehow central governments need to recognize that stronger, more powerful local bodies lead to a stronger more resilient economy and society, as well as to a reduction in the complexity of their own responsibilities and tasks.

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1. Gaël Giraud, interview 30 November 2016 in *Télérama* no. 3490.

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The goal of this book is to address the territorial issue in all its diversity, in particular by a beneficial recourse to an interdisciplinary dimension. In order to do so, we have drawn on the experience and expertise of authors from diverse and complementary domains. We have encouraged a dialogue – made possible by the fruitful and long partnership between Cirad and AFD – between perspectives of the research community and of actors of development.

Our thanks are therefore addressed to the authors, who are listed at the end of the book. We also warmly thank the publishing team, Éditions Quæ and Cirad's Communication Service for their patient and unwavering support. We also thank the reviewers, the members of the steering committee and the editorial committee.

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Introduction

The present enthusiasm for the term 'territory', a concept in which interest has continued to grow steadily over the past 30 years, is not fortuitous. It has arisen due to the increasing complexity of a globalized world, uncertainties about the future of resources, growing inequalities and conflicts. To make some sense of current world reality, we propose a territorial approach, beyond and in addition to an approach based on networks. This can be applied to an administrative territory – a framework for the exercise of power – or to a territory defined by a sense of belonging or by a collective project.

Territories are spaces of coordination between actors in which new forms of governance are conceived that are conducive to development and to the strengthening of solidarity. We want to focus our attention on this vision – which we readily admit is not systematic: on a resolutely optimistic and committed conception of the territory as a vector of sustainable development.

This book summarizes and draws lessons learned from experiments conducted by more than 150 CIRAD and AFD researchers and officers together with their partners. It is divided into three parts. The first sets the stage and offers justification for the use of the concept of the territory. The second part presents a wide range of experiences that shed light on the territory's contributions to sustainable development. The last part showcases methods and tools for intervention and support for territorial development.

In the first part, we explore the upsurge in the use of the word 'territory' in the discourses on development, concomitant with that of the expression 'sustainable development' (Chapter 1). We argue that territories are conducive to sustainable development because of the opportunity they offer to integrate environmental, social and economic objectives and to strengthen the capacity of multiple actors to coordinate and define together the orientations to be pursued. In Chapter 2, we explore the current dynamics of the reconfiguration of rural territories, with a particular focus on Africa. Finally, Chapter 3 outlines the challenges that territories can help address: revamping public action to strengthen regulatory capacities, managing space-based resources and thus contributing to economic development, and organizing the local management of renewable resources held in common.

The second part is devoted to a collection of brief case studies, linking concrete observations, methodological contributions and lessons learned. This diversity of experiences and studies from different continents reflects a plurality of territorial

configurations, actors and projects at different scales. It illustrates how actors, mechanisms, scales and scopes of action interact in the development of rural spaces in the Global South. The chapters in this second part show how configurations and regulations produced by the actors involved in territorial development projects are drivers of change. Thus, Chapters 4 to 8 show the value of organizing the territory to manage resources and Chapters 9 to 13 of organizing it for production. Chapters 14 to 19 show the importance of organizing it to provide services. Chapters 20 to 24 explore how to mobilize the territory as a resource; and, finally, Chapters 25 to 30 propose the mobilization of the territory as a basis for designing public policies.

In the third part (Tools, methods and incentives for territorial development), we illustrate the importance of implementing methods and deploying resources to understand and act on territorial processes, and to accompany the actors involved. Each chapter focuses on a specific aspect of this support: fostering territorial dynamics (Chapter 31), assessing production systems at the territorial scale (Chapter 32), remote sensing and spatial modelling (Chapter 33), territorial observatories (Chapter 34), financial instruments and mechanisms for developing rural territories (Chapter 35), support for decentralization (Chapter 36), and territorial foresight (Chapter 37).

In its Conclusion (chapter 38), the book defends the idea that the territorial approach is a privileged path to achieve sustainable development. The rediscovery of the local scale and its mobilization in order to reconstruct the global one, and thus remake the world, are affirmed as a political project as well as a challenge for research and development institutions. We call for a renaissance of rural territories so that they are able to provide their inhabitants and, more globally, the whole world the full gamut of the economic, social and environmental functions and services essential to peace and social cohesion: well-being, food and nutritional security, human and environmental health, anticipation of and adaptation to climate change, energy transitions, distributed economic growth and decent employment, equity, reduction in migratory tensions, and anticipation and prevention of disputes and conflicts.

Part 1

The territory and the challenges of sustainable development

Chapter 1

Why and how the concept of 'territory' can help in thinking rural development

Patrick Caron

Why the growing interest in the word 'territory'?

The concomitant interest in the term 'territory'[1] and the expression 'sustainable development' is not fortuitous. It has grown due to concerns about the environment and the degradation of resources, increasing inequalities, and tensions and conflicts resulting from hunger, poverty, destitution, migrations, etc. The transformations of rural societies and the risks they face have become issues for intense discussions, passionate debates and preoccupations. They have given rise to reservations of all sorts, on the one hand, and commitments to sustainable development, on the other.

The unprecedented demographic, political, economic and social changes and the intensification of flows and movements through rural areas have rendered obsolete the disciplinary and action frameworks that have been mobilized thus far. These dynamics raise valid and concrete questions about the modes of exploitation, production and reproduction of resources, their appropriation and their use. They call for a relook at the distribution of wealth, the organization of the supply of agricultural products, flows between cities and the countryside, and availability of infrastructure. They call for a revamping of land-use policies and for tax reforms as well as for the reorganization of administrations and services, and of the support of the agricultural sector, etc.

While accompanying the countries of the Global South as they became independent and driven by the goal of helping them catch up economically and socially, the ideology of development was initially based on the paradigm of the welfare state. However, beginning in the 1980s, the watchwords promoted by international institutions within the framework of the Washington Consensus called for

1. Used here and in the rest of the book in its meaning of the French word *territoire*, which encompasses a broader scope – including that of a social construct – than that normally attributed to it in English. See also Foreword to this book by Camilla Toulmin, Box 1.1 in this chapter and Caron (2015).

the disengagement of States. Justified by the political failures or economic bankruptcies of some States, they were also fed by the ideology of popular participation, coupled with demands for democracy and the need to strengthen civil society institutions. In this context, 'the promotion of local development and the policies of decentralization [...] are based on the hypothesis that relations of proximity will better serve the needs of local populations' (Tonneau, 2003). This is especially true in the case of the management of rural areas, for which an abundant body of literature reveals the benefits of increased involvement of local actors, participants and stakeholders (d'Aquino, 2002; Benoît *et al.*, 2006; de Janvry and Sadoulet, 2007; OECD, FAO, UNCDF, 2016). However, some observers did note the limits of participatory democracy and the risks of its instrumentalization.

The need for new regulations emerged in the late 1990s at both local and global levels. The uncertainty that arose about the future – which had long been assumed as necessarily better – and the multiplicity of centres and forms of decision making forged a new context for action. The risks of imbalances that could result from a sole reliance on an extremely volatile – and supposedly 'self regulatory' – market began raising the issue of other ways of guiding transformations in society and the agricultural sector. Even if it remains a political invention, the notion of the public good seemed to make sense and gained rapid and wide acceptance.

This quest for the public good is being accompanied by a rediscovery of the places and the institutional forms necessary for its promotion, not only at the global scale (e.g., Paris Agreement on climate change and the 2030 Agenda for sustainable development) but also at the local level. At the local level, the State, with its intention of disengaging itself, seeks replacements to stimulate initiatives, guarantee the supply or preservation of public goods, and solve emerging problems. Public action is in search of collective action.

Going beyond the reductive acceptations of 'good governance' and 'good practices', new forms of governance must be invented, based on original ways of regulating fragmented social systems. For example, the management of rural spaces and living resources brings together a set of actors with different objectives in a flexible system that has very little or no hierarchy (Soulard, 1999; Perrier-Cornet, 2002). In this sector as in others, the complexity of the issues involved, the reduction of the means of action and the fragmentation of actors and actions undermine the legitimacy of public actors because of their poor ability to resolve emerging problems. Scientists find themselves in the same boat: the assurance of experts and technicians is belied and gives rise to controversies and criticisms of scientific results (Theys and Kalaora, 1992; Godard, 2001, 1993).

This fragmentation of stakes and powers calls for increasingly complex mechanisms of non-hierarchical coordination and arbitration, whether to solve problems of health, the environment, local economics, or those resulting from exclusion, etc. We move from a goal of government of rural spaces by a single authority to a set of governance processes in which all the actors involved exert a part of this now-shared authority, one that is therefore difficult to grasp. Power relations seem to be supplemented, and sometimes replaced, by new forms of negotiated solidarity (Godard, 1993; Lascoumes,

1994) (professional, territorial, of neighbourhood, of class, of user communities, of common interests, etc.). The territory appears to be an eminently suitable field of application of these new processes of governance.

The territory: a useful notion because of its capacity to act on regulations?

The territory makes it possible to understand sustainable development in an appropriate way (Zuindeau, 2010). Irrespective of its size or scale, it promotes the integration of different stakes and activities. The territory and territorial development, understood as the 'capacity of the actors located in a territory to exercise control over its changes and its future' (Deffontaines *et al.*, 2001), are being widely promoted today. It is even surprising to see this reading of the term, much broader in scope than its conventional and specific meaning in English (Caron, 2015), emerge in certain studies in English (Quan, 2008), sometimes via a detour to studies by Latin American colleagues (Schejtman and Berdegué, 2004; Sepúlveda *et al.*, 2003) who came to it from literature in French (Box 1.1 'Landscape' – E. Torquebiau).

In the sense of a social construct (Brunet *et al.*, 1992; Lévy, 1999), the territory – endowed with a historical root, reflecting the identity, including the symbolic identity, of a group (Lévy and Lussault, 2003; Di Méo and Buléon, 2005) – emerges as an essential element of new modes of action resulting from the weakening of hierarchical coordination. The changes observed within territories are the result of the advent of new actors, of the evolution of the State's role and of the tensions resulting from confrontations between actors.

Furthermore, and thanks to the ambiguities inherent in the interest it evinces, the territory imposes itself as framework for coordination between multiple and fragmented actors in situations of asymmetry and with divergent interests. It is a space for harmonizing various objectives (Gumuchian *et al.*, 2003), local as well as global. For some, it is an arena of sustainable development because of its capacity to coordinate multiple actors to define together the orientations to pursue. It is also a space for negotiation (d'Aquino, 2002) for finding coherence between the dynamics of local development and public policies. New forms of governance can thus be invented and tested in a territory: coordination between producers and users of a shared resource, and linkages and synergies between different users of the same space. From a sectoral point of view, the territory makes it possible to link the expectations of a social group and the ability of agriculture to respond to them. As for its economic aspects, thanks to the proximity to and types of social capital that constitute it, the territory can also be a form of organization that can internalize certain transaction costs, minimize economic risks, facilitate learning processes, leverage traditional know-how and knowledge, and ensure quality control of a product or a form of production. These characteristics make it a veritable asset of the production process (Angeon *et al.*, 2006; Pecqueur, 2004; Gumuchian and Pecqueur, 2007; Courlet and Pecqueur, 1992; Boucher, 2004). Indeed, the territory itself becomes a resource. And territorial dynamics themselves become factors of change, modifying social processes and actor

behaviour, for example, as in the case of geographical indications for agricultural products. They lead scientists to renew concepts and analytical frameworks in a way specific to each discipline, such as for agronomy (Caron, 2005).

But is the territory just a portion of space demarcated by its boundaries? A framework for action? A space for organizing production? A marker of past evolutions or a set of resources? The term conceals a diversity of objectives and intentions, encompassing both the administrative territory and the administrative action that takes place in it; the territory promoted or decreed by the State as the site of a project to be built; and the territory constituted around a collective action and to which a sense of identity is attached (Antheaume and Giraut, 2005).

Going beyond this convenient polysemy, most authors agree in emphasizing the feeling of identity expressed by a territory's inhabitants and the existence of institutions that ascribe it with meaning and provide it with governance. Vanier (2009) thus defines it as a 'set of processes undertaken by systems of actors [...], by social and political organizations, by *ad hoc* mechanisms and procedures, by power relations and generated tensions, by economic and structural determinants, by existing generic configurations and/or specific emerging configurations.' It becomes a processor of change. A territory is well and truly governed. That is what makes it a territory: there exists a set of coordinations to regulate a fragmented social system and to act or react to the transformations taking place. The governance of a territory thus makes it possible, or not, to debate the ways and means of sustainable development, of which it is, at the same time, both the vector and the consequence.

Furthermore, emerging territorial forms can be regarded as the beginnings of new organizational models capable of providing answers to a particular problem and able to be leveraged, potentially from a perspective of sustainable development, on a wider scale. These various elements make the territory into a regulatory entity (Boyer, 1986), in the same way as the State or the market, at the interface between collective action and public action and linking local dynamics to global ones (Caron, 2011). It can stimulate local initiatives in a perspective of development, including at more encompassing scales and with impacts at a global level, drawing inspiration from elsewhere or involving the territorial actors in wider initiatives. In an essay calling for the conception of inter-territoriality, Vanier (2008) describes the territory as a 'space socially constructed and appropriated to the point of constituting, at the same time, an identity referent, a regulatory framework and a delimited arena for public action.'

In the agriculture and forestry domain, this growing interest in the territory is driven by a preoccupation to take spatial levels of organization into account that are more encompassing than the level at which the domain's practices are implemented, whether or not they concern factors that influence decision making or induced effects, especially environmental ones. This interest manifests in the English literature by the emergence of a similar terminology. We sometimes speak of the 'landscape' (landscape research, global landscape forum, etc.). However, the notion of territory is distinguished, on the one hand, by the potential multiplicity of scales to which it refers and, on the other, by its social and institutional dimension – both visual and ecological. This is what led David Nabarro, adviser to the UN Secretary-General, to refer to the 'peoplescape'.

For similar reasons, the recognition of the notion of territory has accompanied the emergence of new concepts. In addition to that of sustainable development, the concepts of socio-ecological systems and resilience systems are central to the science of complex adaptive systems (Schoon and van der Leeuw, 2015; O'Neil *et al.*, 1986; Walker and Salt, 2006). All these concepts have some aspects in common: they all focus on the interactions between processes – natural and social – intervening at different scales of time and space; they all favour modes of regulation that steer the evolution of systems; and they are all concerned by the capacity of the territory's actors to manage change. The territory distinguishes itself from other similar concepts by the explicit focus on spatial processes as well as on the institutions and governance mechanisms.

Box 1.1. Territory and landscape.

Emmanuel Torquebiau

There is a certain similarity between the concept of the territory (in its wider meaning of the French '*territoire*') and that of the landscape. While some favour the term 'territory', a socially constructed space in which actors interact (Brunet *et al.*, 1992), others prefer the term 'landscape', a space where species and ecosystems interact. Which of these terms is used often depends on the discipline concerned (the ecologists usually choose the landscape), the school of thought and the objects being analyzed. Indeed, many ecological interactions occur in a territory, and many landscapes are built by man and therefore reflect social dynamics. Landscape ecology has theorized this approach by explicitly considering space, by recognizing man as an integral part of the ecological system and by emphasizing the spatial and temporal heterogeneity of the studied environments (Burel and Baudry, 1999). Although collective action and governance are explicitly constitutive of the territory, which is not the case with landscape, it is possible, even in this book, for one of these two terms to be used, even if other authors of the concerned domain would have preferred the other term. Moreover, the 'landscape approach' integrates many elements of the French *approche territoriale* (see, for example, Minang *et al.*, 2015, or the Global Landscapes Forum, http://www.landscapes.org/, retrieved 20 February 2017), with the term 'territory' usually having generally a narrower meaning in English than in French, especially as regards the social construct.

The territory: the lure of a panacea?

By focusing on it as a vector of consensus and well-being, we forget that the territory is, above all, a matter of power. It is the stake, the *raison d'être* and the mark of the empire or the conqueror. It has been and still remains the cause and the translation of sometimes irreconcilable (Torre and Beuret, 2012) and often destructive tensions, conflicts (Kirat and Torre, 2008) and wars.

In its more recent uses, it has been observed that the invoked participation of local actors can be disingenuous and is liable to lend itself to the bureaucratic fantasies of a disempowered public actor. Either through cynicism or naivety, the result is sometimes

a mockery or an instrumentalization of participation. In addition, a territory is not always managed, i.e., it is not the subject of an intentional process of action and control. And, except in the case of specific public planning actions or military interventions, the processes that produce it are often not steered by any identifiable intention, and, if they are, are usually far from being controllable. The observed changes are most often the result of numerous and fragmented decisions, and of factors and actors acting at different levels of organization, including global. The common expression 'territorial management' which is often attached to the concept of the territory is therefore obviously somewhat of an optimistic misnomer.

The territory is therefore not free from false attributions! In addition, there is also the risk of an inflexible confinement to the local and of identity-based closure – and consequent exclusion –, and of a rigid enforcement of the boundaries that define it. On the contrary, it is porosity, control of flows and networking that can help the territory play the role that we expect from it in a perspective of sustainable development (Vanier, 2008; Caron, 2011). Thus, between potential and risk, it is a real challenge to take advantage of the polysemy that has marked the as-yet young existence of the term 'territory' in order to make it a conduit of action for sustainable development, and to select one of its many forms to help regulate transformations, local as well as global, and to build a new future.

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Chapter 2

Territories and global challenges

Élodie Valette, Denis Pesche and Jean-Philippe Tonneau

Territories and their interdependencies are experiencing a reorganization in the wake of globalization. Traditional North-South divides are becoming blurred and new dynamics are at work in the context of pressing global challenges, such as climate change, and of structural changes such as population growth, urbanization and their impact on resources.

This chapter presents an overview of the main global challenges that are currently affecting territories and their evolutive trajectories, whether local, regional or national. We focus in particular on Africa, illustrating how economic dynamics are accompanied by the emergence or reinforcement of territorial disparities.

A reconfiguration of territorial hierarchies at a global scale

Contemporary territorial dynamics can be viewed in part through the prism of globalization. The increasing flows of goods, products, people, capital and information are reinforcing the links between sectoral economic dynamics and territorial transformations. The reorganizations brought about by globalization are also resulting in new territorial disparities. In many cases, territorial balances constructed over the long term are threatened.

In particular, the traditional distinction between the Global North and the Global South is being blurred not only by the process of differentiation within the former category of developing countries but also by the increase in inequalities, including in industrialized countries. The OECD has expanded to include Mexico and South Korea, along with some countries in Eastern Europe. The Brics (Brazil, Russia, India, China and South Africa), spread across all continents, have begun to emerge as new economic powers. The Arab countries of the Gulf, whose revenues still largely come from oil, are rapidly diversifying their economies and consolidating their strategic position between Asia and Africa. The current composition of the G20 illustrates the gradual abandonment of a vision of development based on the North-South divide, also seen, for example, in the challenging of the industrialized countries' hegemony in international negotiations, such as on biodiversity or climate change.

Despite an increase in global wealth, many countries still remain on the margins of economic development, especially in sub-Saharan Africa. In both the Global North and South, strong disparities are asserting themselves and inequalities are increasing at all levels: regional, national and intra-national. Urban, coastal and tourist areas, well connected to global flows, can be found in close proximity to isolated and marginalized ones. The feeling of exclusion engendered by these dynamics of differentiation can manifest in identity-based and occasionally political tensions, whose consequences in terms of security are still difficult to assess. The growth-based development model is being called into question but an alternative model is yet to emerge.

Global challenges for territories

Demographic growth, particularly high in sub-Saharan Africa and Asia, is one of the main challenges for development in the future. According to the UN, most of the additional 2.4 billion people projected to be added to the world's population by 2050 will live in the least developed regions (UN, 2014). The basic challenges for these populations are and will remain access to education, health, and food security. This population growth is being accompanied by strong dynamics of urbanization, in increasingly large and numerous cities, even though, in Africa as in Asia, the majority of the population is still rural.

Demographic pressure is contributing to increased strain on natural resources (energy and minerals, land, water, wood, etc.). Since the food crisis of 2008, agricultural land has become an increasingly scarce resource, whose acquisition and expansion, including as part of international transactions, has become a major issue. Similarly, the sharing of water resources is a source of tension both locally and internationally. These disputes around land and water resources are set to increase under the expected impacts of climate change. The combined effects of these processes are a challenge to the adaptive capacity of territories, especially of the most vulnerable amongst them.

Under these conditions, the idea of sustainable development leads to doubts over the merits of the dominant economic model, which remains a heavy consumer of resources. Other options, more efficient in their use of resources, have emerged but are often judged to have lower economic performance. And yet, the idea of sustainability requires revising the modalities of evaluating performance to include other criteria. Given this context, the territorial approach is liable to constitute a path towards a more sustainable society (Chapters 1 and 3).

The emblematic example of Africa[1]

In the context of a globalization that has engendered serious tensions, Africa offers an emblematic example of contemporary dynamics. After two decades of structural adjustment policies, Africa has undergone further transformations since the early 2000s: continued demographic and urban transitions, sustained economic growth driven by expanding domestic markets, rising prices of commodities it produces, and renewed foreign investment. These changes inspire optimism, despite worsening

1. This section draws heavily from Losch *et al.* (2016).

conflicts in some parts of the continent and recent slowdown in growth due *inter alia* to the fall in international oil and other commodity prices and to periods of drought in its southern and eastern parts.

The expected addition of 1.35 billion inhabitants to the continent's population by 2050 will affect not only cities. They will indeed continue to grow rapidly but the rural population is expected to remain in the majority until the 2040s due to a continued densification with 350 million likely new residents by 2050. The result will be an increasing overlapping of the urban population with those of rural areas and small towns. The unprecedented extent of various sorts of mobility – goods and people, of course, but also ideas – is shaping new territorialities, stimulating innovation and contributing to the reorganization of spaces.

In Africa, the explosive growth of telephony, the progress – albeit still hesitant – towards access to energy and the construction of major transport and irrigation infrastructure has greatly increased the attractiveness of certain territories, sometimes to the detriment of others that are less well endowed. The expansion of mining and other extractive activities and the attraction of local and foreign investors to the most fertile agricultural lands are often highlighted as new levers for development. But the integration of the African continent into globalization remains weak, with exports consisting mainly of primary products with little or no processing (minerals, timber, agricultural commodities). While these activities inflate growth in absolute terms and, in some countries, stimulate dynamics of investment, they rarely have real knock-on or multiplier effects, create few jobs and do not benefit the majority of the population.

Another aspect of rural transformations is no less important, though less visible because of its fragmented nature and lack of exposure. Rural families are often forced to combine multiple revenue-generating activities, both in town and in the countryside, sometimes taking advantage of the resources of migration, in order to maintain their viability in sometimes isolated territories.

Africa will not develop merely through its insertion in the markets by the production of commodities, nor through the dynamics of urbanization and metropolitanization. The rebalancing of territories will also depend on the support extended to rural dynamics and the growth of secondary cities. Otherwise there is a great risk that the phenomena of rural exoduses and large-scale migrations to the most populated urban centres will not only continue but increase, creating in the process large areas of spatial marginalization. The absence of significant compensatory financing, the disengagement of public authorities and the abandonment of the territories are an open invitation to lasting instability. Tackling these challenges requires reliance on all available territorial resources and on those of cities and rural areas in order to leverage the diversity of existing spatial dynamics.

Conclusion

The global dynamics presented here are far from leading to a homogenization of territories at a global scale. Indeed, far from an 'end of the territories' that was once predicted (Badie, 1995), we are witness to growing differentiation and the emergence of multiple models of development.

Are we seeing the end of a model based solely on economic performance in favour of a pluralistic vision? Is this vision oriented towards the new objectives of sustainable development which, unlike the Millennium Development Goals, concern the countries of the Global North in addition to those of the Global South?[2] Without falling into the trap of a dogmatic localism, we can assert that a combination of locally rooted strategies that emphasize the development of territorial resources and better control of global flows and changes can be a path to territorial development.

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2. The UN General Assembly adopted 17 Sustainable Development Goals (SDGs) consisting of 169 specific targets between them on 25 September 2015 in New York. They formally take over from the eight Millennium Development Goals (MDGs), which were launched in 2000 and expired in 2015. The SDG agenda for 2030 focuses in particular on the fight against poverty, inequality and injustice, and action against climate change.

Chapter 3

The territory: a response to the development crisis

Jean-Philippe Tonneau, Denis Sautier, Élodie Valette, Muriel Figuié, Gilles Massardier and Patrick Caron

The dynamics described in Chapter 2 are far from being always conducive to sustainable development. Thinking and acting at the territorial level can contribute to development by improving the capacity of local stakeholders to adapt and control their future and, in this way, increase their resilience. The expansion and intensification of trade lead to increased international competition. As a consequence, rural societies in the countries of the Global South are experiencing brutal shocks. Disparities between regions are tending to worsen. Economically efficient production zones with adequate infrastructure, skills and facilities coexist with marginalized areas such as the so-called 'shadow zones' in Tunisia. (Tonneau, 2003).

This trend, accelerated by three decades of disengagement by the nation States and structural adjustments in the name of political and economic thinking propagated by the Bretton Woods institutions, has forced major disruptive changes on agriculture and rural territories. National protection mechanisms have been dismantled, aid and subsidies abolished, national regulatory systems loosened, price stabilization funds dissolved, and competition introduced in conditions that are highly variable but always risky. During this period, development policies have been generally designed to stimulate innovation and entrepreneurial freedom, in particular by facilitating private investment and mobility of capital. These policies postulated, on the one hand, that these measures would induce growth and, on the other, that the liberal model underpinning them was an instrument of redistribution for the good of all – subject to compensations for any inequalities and adverse effects caused by these transformations. To put it mildly, this has not always been the case.

Competition effectively pits territories against each other (Lamarche, 2003). The differentiated integration of agricultural producers into the market leads to the structuring of space and produces or amplifies social divides (Tonneau, 2003). The resources invested here are not available for social and environmental policies. Limited redistribution does not successfully fulfil a leveraging or multiplying role.

The resulting tensions underscore the importance of addressing the social and environmental impacts of production. These concerns are at the heart of the challenges of the 2030 Agenda for Sustainable Development[1].

The future for sustainable development seems to be uncertain even though the feelings of crisis and risk and the perception of inadequate regulation have created a broad consensus: it is no longer possible to continue doing 'business as usual'. Combating poverty is no longer just a moral and charitable obligation, but a necessity in order to avoid the collapse of social cohesion and, worse, of identities. But how do we go about it? As far as the environment is concerned, States have become aware of the damage to it and the problems surrounding it, but are unable to imagine the ways, means and tools of public action to address them.

In fact, the questions being asked are themselves changing. What is the capacity to monitor and regulate developments at all levels, local, national and global? How to transform the action of a sometimes ineffective and even corrupt State? How can we rethink the regulatory processes that have been overtaken by the rapid changes taking place and by the political and institutional actions of recent decades? And, in the context of our concerns here, how can the territory and territorial development contribute to a greater resilience of social groups, a better regulation of the observed processes and, ultimately, to sustainable development? It seems to us that there are four main issues to consider in order to answer this last question.

Ensuring that the territory contributes to the transformation of public action

In a context of the weakening, even of crisis, of the nation State described in Chapter 1, the transformation of the State's actions is based on the evolution of forms of public action. This change requires the involvement of multiple actors, not only of those belonging to the State, in the weaving of the 'fabric' of public policies (Duran and Thoenig, 1996). Over the past two decades, two processes have been at work, either separately or simultaneously. The first is the promotion of the exercise of powers by local communities through policies of decentralization and devolution of States or through the policies of territorialization that attempt to include the participation of all territorial stakeholders in management mechanisms. The second is the entry into the political arena of economic and social actors, in particular NGOs and producer organizations in the agricultural domain, through actions to support the direct participation of local populations. Since the 1950s, local development experiments, based on collective action and on the structuring of territories, have frequently been used to manage water resources, control the quality of products, ensure market presence through commercial organizations, etc. These phenomena can be observed in many countries.

1. On 25 September 2015, the United Nations General Assembly adopted a Sustainable Development Agenda for 2030, with 17 Sustainable Development Goals consisting of 169 targets between them in the areas of economics, social development and environmental protection.

At the start of this third millennium, the territorial project can be defined as a set of actions agreed upon by all the actors involved. It appears to be a hybrid object, founded and driven by dynamics of local development and providing content and a framework for action to territorial authorities in search of meaning. It thus strives towards two goals. The first is to acknowledge the willingness of the local populations to take control of their destiny and to better manage the evolutions that affect them (Deffontaines *et al.*, 2001) by refusing, through an endogenous organizational approach, 'the sole logic of the market for generating value from human and natural resources' (Mengin, 1987). The second is to invent and give shape to a new public action in association with structures – which were earlier circumvented – of the decentralized and often disoriented State.

As decentralization progresses, so does the planning of territorial policy. These processes are illustrated, for example, by the management of natural resources (water resources by watersheds, for example) or by the emergence of inter-municipal cooperation for the purpose of managing land in urban and peri-urban situations. Territorial policies have three main characteristics. First, they are planned at multiple levels and seek to link local priorities and demands with management actions planned at the national level by connecting territories with each other, especially rural and urban ones. Second, they try to link and integrate the different sectoral policies, which are often ignorant of one another, within the territorial framework (Losch *et al.*, 2015). Finally, they promote and support the participation of local actors, including at other scales, such as the national or even the global.

Over the past 30 years, this participatory imperative has resulted in specific procedures: participatory budgeting, territorial committees, local consultations, etc. More importantly, the traditional phenomena of local networks or coalitions are reinforced, with the territories' actors demonstrating a growing ability to participate in public action. After a period of circumvention of the State, what is taking place is a reappropriation of territories by the actors and a strengthening of democracies, including in political construction at more inclusive levels, especially at the national level. This is a propitious way to ensure coherence, peace and regulation: in sum, to move towards sustainable development.

Activating territorial resources and capacities

In order to face the challenges of sustainable development, it is not enough to consider the territory as an appropriate scale for rethinking public action. Because it is built historically, connected through social links, and because geographical proximity may often provide an organizational and institutional proximity, the territory can also, under certain conditions, act as a catalyst for the transformation of sectors and economic development. The territory brings together tangible and intangible natural and human assets, which when set into motion give meaning to the processes of development. Such a capacity to constitute a place for the activation of resources and to serve as a platform for new initiatives explains this apparent paradox: in our era of accelerated globalization of information and trade, an unprecedented interest has arisen in local development and territorial dynamics! Indeed, the local and the global

do not really oppose each other, they stimulate each other. Michael Porter (1998) sums up this idea well: 'The enduring competitive advantages in a global economy lie increasingly in local things – knowledge, relationships, motivation – that distant rivals cannot match.' As the world becomes more and more globalized, local issues become increasingly relevant and resonant.

This potential of territorial dynamics is not uniformly expressed. Regions gain while others lose (Benko and Lipietz, 1992; Côté *et al.*, 1995). How can these different itineraries be explained? Industrial economics analyzes the interactions between a local system's actors to assess its collective efficiency. Alfred Marshall (1890) demonstrated that an industrial district (or cluster), i.e., independent, small-scale firms specializing in the same sector, can have an economic efficiency comparable to that of large integrated firms (Fordist model) provided that these firms are clustered together in the same territory and work in relationship with one another (subcontracting, partnerships, etc.). Marshall advanced two explanations. First, the similarity of values and behaviours between actors reduces the costs of market transactions and limits the risks of opportunism (pecuniary externalities). Second, a dense network of relationships between local actors promotes learning processes and the dissemination of uncodified know-how. This stimulates innovation (technological externalities), because innovation is generally the product of a combination of codified knowledge and tacit knowledge (Fournier and Muchnik, 2011).

A virtuous circle of territorial development may then be established, removing obstacles and avoiding failures. At the heart of this process, which will be thoroughly explored and discussed in this book, stands the necessary articulation between three key elements: the notion of territorial resources, the activation of these resources and capacities, and the territoriality of the actors.

The term 'territorial resources' encompasses not only the material resources that a territory contains (such as raw materials or a period of sunshine), but also ideational resources: knowledge and skills shared by the territory's actors; the projects' dynamics; the institutional framework, etc. (Gumuchian and Pecqueur, 2007).

'Activation' of resources and capacities means their engagement in a targeted productive operation. For example, a very abundant 'sunshine period' resource is a constraint for some crops, but can also be activated for a tourism activity, which will become a specific asset of the locality. Similarly, dairy production in a territory can be activated by transforming the milk into cheese using manufacturing capacities and know-how. The asset thus obtained can then in turn become a resource for a new step of activation, for example by creating a safe-food certificate or a territorial label for this cheese. At each step, resources and capacities are thus used to generate value in order to create a new territorial asset (Boucher, 2004).

In this process of activation of resources, it is ultimately the actors' territoriality that matters the most. It counts for more than the territory's spatial delimitation which remains always subject to modification. Territoriality is the actors' ability to assimilate the territory and its resources as a strategic component in the pursuit of their goals. To take the example of the dairy sector, 'territorialized' actors are producers, processors and traders whose future and survival depend closely on the future and survival of

local dairy production. These actors make a distinction between the space in proximity and the rest of the world, not only because of transport costs, but also because, on the one hand, the former is more intelligible to them, with the territory acting as an interpretive filter (Pecqueur, 1996); and, on the other, the building of relationships of trust is facilitated by the existence of shared norms and values.

However, the local is not an attribute that remains unchanged over time. It is the process of localization (or of delocalization) that interests us, i.e., the process of anchoring (or of uprooting) of resources and capabilities *vis-à-vis* a given society and biophysical environment. This requires a better understanding over the long term of how 'localized skills' are built up, that allow not only the continuation of what already exists, but the making of strategic choices and the undertaking of reorientations necessary for sustainable development.

Relatively recent experiments have shown the importance of this return to the local for products where appellations of origin were hardly imaginable *a priori*. An example is the success of Guérande salt in France. In the 1970s, salt workers in crisis took up the challenge of differentiating the quality of their salt, by relying on their knowledge and their region's history and heritage (Muchnik, 2003). Today, 125 grams of 'fleur de sel' from Guérande sell for almost 4 euros, thanks to the meeting of a profession, a location, a product and a supply chain. Similar experiments with salt are now underway in Spain and Portugal.

This territorial anchoring of sectors also pertains to 'the link between the local and the global, between social constructions and local policies, and global regimes' (Biénabe *et al.*, 2017). Research spanning across the territory and the sectors or value chains is essential to apprehend the scale of the challenges of economic, social and environmental development, whether to mitigate the risk of a withdrawal to what is local, or to guard against centralized control by mechanisms of national or international supply chains.

Rethinking the management of renewable resources by the commons and strengthening the link between collective action and public action

The work of Elinor Ostrom, which won her the Nobel Prize in Economics in 2009, has inspired continuing research on the management of resources shared between different stakeholders for different uses (infrastructure, renewable resources – water, forest, even an inhabitable climate). Hardin's (1968) theory of the 'tragedy of the commons' to explain situations of collective overexploitation of a common resource led to the notion of the commons to describe shared resources, managed collectively according to institutions and rules established by the users themselves, in the North as in the South (Ostrom, 1990). All objects of shared use, such as transhumance corridors, local territories and complex ecosystems, are increasingly being recognized and mobilized for territorial planning and development, often to symbolize an alternative to the system of liberal economic regulation (Dardot and Laval, 2014).

Collective land in the Global South is being affected by land appropriation (or land grabbing). Global changes, such as population migrations or shifts in production centres, are changing land use patterns and often leading to the overexploitation, degradation and increased vulnerability of natural resources on which depend the living conditions of millions of people around the world. Infrastructure for managing resources, such as, for example, irrigated perimeters (Chapter 5) or fishing grounds, is unable to absorb the growth in numbers of beneficiaries. The competition that arises as a consequence affects the state of ecosystems and the resilience of the social groups that live in them.

In particular through the forms of governance they generate, the commons constitute a unique form of territorial production. The notion of the commons can contribute to thinking on territorial development challenges, old as well as new, by focusing on the multiple and complex regulations implemented by the actors for managing resources. It also highlights the importance of recognizing the scope of institutional forms designed for managing the commons and which can be mobilized for other actions concerning territorial development.

Integrating the actions of networks and territories

While the territorial approach is a preferred way of thinking about and implementing sustainable development, socio-spatial phenomena marked by the mobility and flow of people, goods, capital, funds, information, viruses, etc. cannot be analyzed in a framework of a conception of contiguous and demarcated space and its management. Many of these phenomena are best analyzed as networks and do not, in fact, respect spatial boundaries (Négrier, 1989). It is therefore also appropriate to refer to a territory conceived as an arena for various phenomena to occur and act in.

Health (human and animal), biodiversity conservation and national security are traditionally managed through public policy instruments based on territorial categorization. For example, health crises result in zoning and quarantine measures. Management of animal infectious diseases is based on an assessment of risk linked to spatial proximity. It justifies slaughter strategies according to concentric perimeters defined on the basis of the reported outbreak and its risks, or restrictions of movements and marketing of animals, which affect an entire territory.

Similarly, conservation of biodiversity is ensured by the demarcation of parks and nature reserves, protected from external anthropogenic pressures. And national security traditionally relies on the erection and protection of borders aimed at preserving territorial integrity. In all such cases, it is a matter of protecting territories from external threats, through measures ranging from segregation to geographical sequestration. However, this method of management has its limitations. In a globalized world in which exchanges and trade (of individuals, goods, etc.) continue to increase, the threat – health, military, demographic or economic – no longer depends solely on geographical proximity. It also depends on the existence of networks with multiple anchorages (Cortes and Pesche, 2013), such as commercial networks in the case of animal health or terrorist networks in the case of security. Furthermore, protection by

'confinement' now stifles as much as it protects. The management of the last Ebola epidemic is a case in point: border closures and quarantines had consequences not only on the capacity to manage the crisis (difficulties in conveying healthcare personnel and in delivering equipment) but also contributed to an expansion of the health crisis to an economic crisis because of the interruption of trade needed for productive and economic activities, not to mention their social and political impacts (FAO, 2016).

The threats are evolving more rapidly than the tools used to manage them. However, an increasing number of mechanisms to control flows are seeing the light of day and are being used in conjunction with traditional territorial protection tools. In the health sector, for example, traceability tools (Torny, 1998) and sanitary standards make it possible to address individual supply chains and sectors rather than territories, in particular for managing foot-and-mouth disease (Thomson *et al.*, 2013). In the area of biodiversity conservation, mechanisms for connecting territories are emerging – ecological corridors, transboundary parks, etc. (Wolmer, 2003). And in the area of national security, the State has to monitor the fluidity of exchanges as much as it protects the integrity of territories (Gros, 2012).

It is therefore a matter of thinking of territories, in their interrelations and interdependencies, as spaces traversed by flows whose management is outside the scope of a solely territorial approach. CIRAD is contributing to identifying the real consequences of these transformations, in particular in 'marginalized' territories (Andersson *et al.*, 2013 ; Figuié *et al.*, 2015).

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Part 2

Diversity of territorial functions and approaches

2-1 – Organizing the territory to manage resources

Chapter 4

Agro-industries and territorial development: the role of land policies

Perrine Burnod, Jérémy Bourgoin and Élodie Valette

In sub-Saharan Africa, countries are increasingly relying on the private sector to be a driver of development of their territories. In order to attract these domestic or foreign private operators, these countries extol the abundance of their land resources and ease of starting operations. After more than 20 years of land policies aimed at securing the rights of family farmers and at managing natural resources, land policies are now also focusing on facilitating the transfer of large agricultural lands to investors. Is this the start of a reverse agrarian reform, sweeping away in one go all the painstaking efforts of the past devoted to local land management and land tenure security? This chapter examines the nature of these changes and their implications for territorial development. It explores how experiences and tools acquired in the context of past land policies play or may play a role in the territorial integration of these firms. This chapter is based on two emblematic cases. The first is Senegal, a pioneer in innovations pertaining to territorial management and very active in welcoming agribusinesses in search of irrigated agricultural land. The second is that of Madagascar, home to land reforms that legally recognized customary rights and an El Dorado for many investors. Madagascar is also famous for the Daewoo scandal that underscored the sensitive dimension of land policies: the revelation that the Malagasy government was on the point of leasing about 1.3 million hectares of land for 99 years to Daewoo, the South Korean multinational, contributed to the fall of the incumbent president in 2009.

From enhancing the security of family farming to welcoming agribusinesses

Land policies can affect the distribution of land tenure rights (allocating or transferring rights as in the case of land reforms), the securing of rights (registering rights through titles or certificates) and land management by defining which entities have the power to allocate and recognize rights. In Africa, throughout the 20th century, land policies shifted from an objective of granting rights to large agricultural enterprises (colonization) to an objective of securing the land tenure rights of family farms

(independent nations). Since the 1970s, land security policies have also evolved. They have transitioned away from an objective of imposing a private ownership system manifested by land titles and managed by the State administration (1970-1980) to a goal of recognition of customary rights and decentralization of land management (1990s to the present) (Le Roy, 1996; Colin *et al.*, 2009; Lavigne Delville, 2010). Do the transfers of thousands of hectares by African governments show a return to land allocation policies that benefit large companies? Or do they indicate renewed land policies that are attempting to combine objectives of allocating land to investors with past advances in local management of land?

In Madagascar, since the early 2000s, national and local government representatives have leased thousands of hectares to private companies and individual investors wanting to set up very large agricultural projects. In 2016, as a result of the abandonment of their projects by a large majority of economic operators[1], only 50,000 hectares were leased in the agricultural sector and of these, only 10% were being actually used. The few agricultural enterprises still active have had very mixed impacts in terms of employment and investment in infrastructure (ranging from 1 to 100 jobs per 100 cultivated hectares).

In Senegal, municipalities, with the support of government services, have allocated thousands of hectares to private operators to the extent that some have even granted more land than they had (case of the municipality of Mbane)[2]. Investments continue to flow in for vegetable cultivation projects. At the request of local populations or on their own initiative, companies are getting involved in creating or improving local infrastructure (schools, irrigation canals) and in supporting the livestock sector (creation of water points, provision of crop residues).

Local land-related innovations not fully taken into account

In Madagascar, since 2005, ongoing reforms have brought in two major innovations. First, they legally recognized customary ownership rights over untitled lands (lands belonging to the legal category of 'untitled private property'). Second, they decentralized the management of untitled private land to municipalities and empowered them to set up land offices and to issue land certificates[3] (one-third of the municipalities currently have land offices). However, these two major aspects have had a limited direct effect on the regulation of large-scale land transfers (Burnod and Andriamanalina, forthcoming). To begin with, the land selected for investments is mainly pastureland that is effectively in use by the herders but is not classified as untitled private property; the law does not consider animal grazing as an obvious or sufficient appropriation to

1. 90% of the 85 investors abandoned their project due to the political crisis (2009-2014), their lack of experience in agriculture, insufficient funding and difficulties in accessing land (obtaining the agreement of the government, on the one hand, and of local populations and authorities, on the other).
2. The government, engaged in a joint venture, has declassified a part of a sylvo-pastoral reserve, previously used by livestock herdsmen, to accommodate a Senegalese-Italian company (SenHuile/SenEthanol).
3. Issued on the basis of a social consensus, the land certificate formalizes private ownership of property and is legally similar to a land title.

legally recognize the customary rights so it continues to classify such land as State domain (Law 2008-14). Moreover, the land transfers took place in municipalities that had not yet set up land offices. Finally, in spite of the legal requirements, customary owners were little involved in the selection and demarcation of land for investors. Those who did have this opportunity had neither the knowledge of the laws nor the support of land offices' staff to legally defend their lands and to claim that these lands belonged to the category of untitled private property. They did not oppose the land transfers, beguiled by promises of employment and infrastructure development, and reluctant to protest against projects they believed had the State's endorsement.

In Senegal, debates on land reform have been going on since 1996. In accordance with the 1964 law still in force, customary rights on national land are legally recognized as usage rights but not as property rights. Furthermore, since 1996, the municipalities have acquired new powers. They can allocate land temporarily (allocation procedure) to recognize occupation of land by existing farmers or to let new farmers use it. Since the 2000s, municipalities in the Senegal River valley have wholeheartedly invested in a coordinated management of their territory through the rollout of participatory land use and management plans (French acronym: POAS) (d'Aquino *et al.*, 2002). These plans have made it possible to establish a range of concerted management rules, which go beyond a mere zoning scheme. They have encouraged the recognition of a certain pluriactivity of local production areas or *terroirs* and reinforced the legitimacy of local authorities as managers of the municipal space. However, these new powers have not been systematically leveraged to good effect. With the support, or even the instructions, of the State and promises of benefits from private operators, some municipal officials have sometimes allocated large areas in contravention of the law that requires beneficiaries to reside in the municipalities and to obtain free and prior consent from local populations. Land use and management plans, which had allowed the creation of a range of concerted management rules, have sometimes been forgotten.

In both countries, priority has been accorded to operators willing to invest, with administrators ignoring – sometimes deliberately – land tenure laws and the rights of families of farmers or livestock herders living on the land concerned.

Innovations in land security and land management

Protests against large-scale land transfers broke out in Madagascar in 2009, and in Senegal a few months later, forcing policymakers to review their strategy of welcoming investors. The experience with land policies of the past has led to complex indirect effects: attempts at recentralization of land management by the governments, on the one hand, and greater participation of civil society in land governance, on the other.

Far from putting a halt to land transfers to investors, both countries' governments recentralized the management of these transfers, not only to capture the symbolic and economic benefits associated with these investment projects, but also to reassert their authority over decentralized entities (Burnod *et al.*, 2013). In Madagascar, starting in 2010, the land administration imposed an obligation on all investors to first approach the national government. In 2015, it decreed that the boundaries of private untitled

land should be frozen within the framework of municipal development schemes in order to identify State property and to create, under its primary responsibility, agricultural investment zones (MEPATE, 2015). In Senegal, the government launched the Sustainable and Inclusive Agribusiness Project for Senegal (French abbreviation: PDIDAS) in 2014, which promotes growth and employment by increasing private productive investments in agriculture (Louga and Saint-Louis regions). This project is trying out a new procedure to control access to land, with support from the reform commission: the State registers the land in the national domain in its name and leases it to the municipalities. The latter can then allocate this land to farmers or businesses through sub-leases. In each of these countries, these developments are undermining the process of decentralization, as procedures for allocating land to investors would now require approval from the national government. This process could encourage private enterprises to deal directly and exclusively with the State.

At the same time, the commitment, sometimes long-standing, of these countries to undertake land reform (in Senegal as part of the Agro-Sylvo-Pastoral Orientation Law of 2004) has gradually increased the interest in and capacities concerning land matters by civil society and local authorities (funding for civil society platforms concerning land; legal training for experts, elected officials and municipal officials; participation by all land users in drawing up land use and management plans). Civil society networks are therefore now very present in debates on land reform and on support for territorial land management. In Madagascar, civil society has thus been able to defend the protection of the rights of livestock herders under the new land policy. Similarly, the land observatory initially created to monitor land reform and which was later included in the ambit of ministerial responsibility, was able to make public information on leases issued by the State and the problems concerning security of land tenure of populations and investors. It has also proposed the development of legal and technical innovations. In Senegal, in 2015, the Framework for Reflection and Action on Land Tenure in Senegal (French acronym: CRAFS), which brings together many NGOs, initiated the setting up of an observatory of land governance. This mechanism to monitor land dynamics aims to promote tools of territorial management and reflections on how they can best be applied.

Conclusion

Because they define the modalities of access to land and decide on the allocation of rights between competing users, land policies are at the heart of sustainable management of socio-ecosystems and territories, economic development and social justice. In the two countries we discussed in this chapter, the respective national governments grant investors a priority in access to land and, by allocating large areas and beneficial conditions for their operations, commit to the resulting land concentration. They are reaffirming their authority over the municipalities and their ownership of marginal and remote land (Madagascar) or of land known for its potential (Senegal) by registering land previously devoted to livestock herding or agriculture in the name of the State and then allocating it to private operators with foreign capital. At the same time, innovative land tenure mechanisms (laws protecting customary rights,

land offices, land use and management planning, etc.) have regulated large-scale land transfers indirectly through the reinforcement of actions and justification registers of civil society, and through support for land observatories. These innovations are key regulatory tools that must be promoted and defended politically so that they can become truly effective and be able to contribute to territorial development.

The contributions of each of these two countries' reforms could inform the debates in other countries on land management and diversify the ways in which civil society participates in territorial development. The experience of land use planning and management in Senegal could encourage the implementation of innovative tools in Madagascar to overcome the pitfalls of a top-down management scheme, to discuss competition in access to resources between users, and to accompany the political choices in this direction. Similarly, the experience of the land offices in Madagascar could be used for the creation of municipal land offices in Senegal and for informing the reflections on how best to help these local structures stimulate debates on land governance, and, where collectively desired and approved by the local population, identify suitable lands for private investors and compensations for local populations. The land observatory in Madagascar already plays – and the observatory on land governance being set up in Senegal will play – a fundamental role in this regard and are, in both cases, supported by the research community. They can lead to the capitalization of experiments and the monitoring of changes in land use and tenure. Above all, they provide platforms for debates on territorial issues. Bringing together a set of actors in a process of pooling and sharing of knowledge, they have to be the spearheads of innovative and concerted land policies.

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Chapter 5

Is the concept of territory miscible in irrigation water?

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The expansion of irrigated agriculture requires the construction of expensive hydraulic infrastructure (Kuper *et al.*, 2009), which exists in areas as diverse as the North African plains, the flood valleys of West Africa, or the mountains of Southeast Asia. Irrigation schemes, hydraulic infrastructure (dams, canals, drains, etc.), roads, electricity networks are constituent of irrigated areas and lead to changes in landscapes, ways of managing spaces and societies' relationships with these spaces. But do these developments constitute territories?

In wet areas with no water control, the literature notes strong links between territory and water, using the terms 'hydraulic territory' or 'water territory' (Riviere-Honegger, 2008), with uncontrolled water imposing its spatial mark. In contrast, a direct relationship between the territory and irrigation schemes is more rarely established. Is it because the latter are seen as modern objects, destructuring traditional hydraulic societies perceived to be in harmony with their environment? And yet, the development of irrigation facilities, almost always at the behest of and carried out by the State, is a process of territorialization, in the sense of 'all the procedures through which a territory is formed and evolves' (Turco, 1997). These irrigation facilities structure spaces in relation to the water resource (river, groundwater, reservoir, etc.). The activities are organized depending on the distance to water resources (surface or underground), which varies over the course of the seasons if the water resource is not perennial. Each hydraulic space is also a social space dependent not only on geographical rationales but also on political, symbolic and ideological ones (Riviere-Honegger, 2008).

Irrigation schemes, very clearly delimited geographically, reorganize the living environment, agricultural production, and the flow of goods and people. At the same time, they also represent social spaces that evolve, develop or reinvent themselves. Irrigation facilities encourage the concentration of populations in cities within or near the schemes and transform habitats, production systems and consumption patterns. The supply and marketing chains more easily become part of globalization. Human

communities, marked by migratory flows and growing social differences, change their management methods profoundly, according priority to collective water management mechanisms. Managing the irrigated areas and the water that supplies them involves political, societal, and geographical dimensions at different scales, ranging from village plots to production basins, or from the smallest lowland to the river's watershed.

Irrigation facilities do make the territory. This is what we illustrate through case studies that encompass a diversity of situations, forms (geographical, hydraulic, and social), and governance mechanisms.

The territory and irrigation

In West Africa, the Senegal River and the Niger River have been the subject of concerted international management for decades.

In the 1970s, it was decided to develop infrastructure along the Senegal River – which forms the border between Mauritania and Senegal – with a hydroelectric dimension that was very structuring in economic and political terms. But while traditional village territories were part of a complementarity between the two banks along the meanders – the concave banks being used for cultivating flood-recession crops in the basins and the convex banks being used for dwellings and rainfed crops – the processes of independence of these two countries from colonialism and, then, the violent Senegal-Mauritania conflict in 1989-1991, transformed this river from a link between village territories to an unfordable obstacle. Although the situation has been normalized, different rationales of development and of political and social organization have driven changes on either shore. Cross-border village territories based on flood-recession farming have been replaced by territories polarized by irrigation schemes on each side of the river, which have largely ignored local populations. In order to meet national requirements of rice, priority has been accorded to agribusinesses, to the detriment of more diversified development.

In Mali, the irrigation scheme of the Office du Niger – often described as 'a State within the State' – is a large, irrigated, autonomous territory with its own ministry. It has replaced the various agro-pastoral territories that existed there earlier. Built on the basis of canals, rice fields and populations displaced for irrigation, the infrastructure facilities determined the creation, in each hydraulic block, of a village named after it (N8, KO2, etc.). Following appeals to investors, current scheme extensions are nibbling away at and disrupting non-irrigated areas dedicated to extensive livestock husbandry (Adamczewski *et al.*, 2015). Livestock breeders are turning into irrigating farmers or agricultural labourers. Only the young people now take part in transhumance, modifying the relationship of an entire society to this space that, until recently, was completely open but is today laid out with canals, drains and tracks. Small administrative towns have become centres of communication and economic hubs, connected with diverse markets.

In both Senegal and Mali, irrigation schemes are the new neighbours of old livestock husbandry territories. Even though farmers and livestock breeders have contrasting relationships with space – intensive use *versus* extensive use of resources –, they are

in competition for this space and water use. While other reasons may have been the root cause of the Senegal-Mauritania conflict, the trigger was the disputes between nomadic livestock herders and irrigating farmers for access to the Senegal River (Bélières *et al.*, 2013). By considering this irrigated territory as a geographical space constructed by the actors and their networks, we will be able to analyze the forms of synergy and cooperation that exist between livestock husbandry, peasant agriculture, agro-industry, etc. This could lead to a redefinition of the social and geographical scale of territorial development along a major river on the basis of a better understanding of the dynamics induced by irrigation.

Elsewhere in West Africa, small-scale irrigation facilities aim to improve the use of water in inland valleys. Infrastructure built in the lowlands is managed at a very local level and only affects the use of water and land in one or two village territories. The creation of micro-dams reorganizes the village territories concerned: formerly centred on the higher, drier zone, they shift towards the low, floodable and irrigable zone with high production potential. Agricultural activity is no longer determined solely by the rainfall calendar but also by floods and changes in the water table level. Inter-annual rainfall variations, especially wide in the Sahel, are being exacerbated by climate change and by changes in flows in water courses induced by the clearing of drained areas and the succession of small irrigation facilities in the valleys. These hydrological changes, however, do not mean that the large catchment area can be termed a 'hydraulic territory', mainly because it is not (yet) a common management space and very rarely a space that is a subject of integral planning (Hertzog *et al.*, 2012). The development of floodplains near the Senegal River is a characteristic example of the difficulty of defining management scales. For the sake of the goal of food self-sufficiency, the government wants to transform these basins into small rice-growing areas. Researchers and NGOs propose instead low-cost facilities for supplying water to livestock and market gardening activities that would, above all, guarantee the continued existence of a diversity of production systems.

In Morocco, Kadiri *et al.* (2013) analyzed the impact of the implementation of an irrigation project in a rural area. They show how this territory – the development of which was planned and defined by the government through the creation of an irrigation infrastructure – is evolving through the local actors, with individual and collective dynamics often other than those originally defined or expected. For example, irrigation associations quickly crossed the project's boundaries to irrigate other land. New leaders emerged, in competition with incumbent public figures. Drawing legitimacy from their management of water or agricultural cooperatives, these leaders are now distinguishing themselves in local development projects (drinking water, rural roads) or in local politics.

In South Africa, the policy of apartheid and, in particular, the Tomlinson Commission of 1955 forged a strong link between irrigation and territory because, in an effort to ensure subsistence-based development through a combination of irrigated farming and rainfed livestock husbandry, many small irrigated schemes were developed in areas reserved for black populations. This plan never really worked because the South African black peasantry, its habits, its knowledge and its culture had been completely

dismantled starting at the end of the 19th century and throughout most of the 20th century (land grabbing, massive forced displacements). The territories into which the black population was concentrated (13% of the country) often had poor soils, were lacking infrastructure and services, and were located far from supplies and markets. These populations were, for the most part, displaced, with no local knowledge of resources, climate and crops, and whose main activities had been non-agricultural. Support was offered by government development agencies (called 'corporations') in a paternalistic way and was limited to physically operating the irrigation facilities (construction, maintenance). They paid little heed to strengthening the actors' capacities or to seeking agricultural or commercial alternatives. With the end of apartheid, the dismantling of corporations and the advent of post-1996 liberal politics, the facilities in the irrigated schemes fell into disuse and subsequently became degraded, most of them permanently (Perret and Farolfi, 2005).

Finally, in Brazil, in the São Francisco River valley, public investments (dams, roads, irrigation schemes) have made it possible to create a large expanse of irrigated fruit trees, with a high level of investment and technical expertise, constituting a major fresh fruit exporting area (more than 90% of Brazilian grape and mango exports). Large agribusinesses and medium-sized family enterprises (smaller than 20 ha) coexist (Coudel *et al.*, 2008) in this valley. The location of the irrigation schemes on the outskirts of the Petrolina-Juazeiro conurbation – old towns both – has promoted processing activities and services in support of agriculture. The involvement of Brazilian companies has helped avoid the enclave phenomena observed around rubber and oil palm plantations elsewhere in the country. Even if the term 'territory' is little used, this production basin has the characteristics of one: an administrative region intended to link and coordinate projects and initiatives was created in 2001, bringing together eight municipalities from two Brazilian states; an identity around the São Francisco River is being formed; and a project is being set up around the Petrolina-Juazeiro conurbation without, however, succeeding in correcting the environmental and social consequences of what is essentially an economic development.

Conclusion

Even if the word itself is rarely used to designate the spaces covered by irrigation schemes, the notion of territory seems pertinent and even fundamental for analyzing them. No doubt, the initial impetus behind the developments remains technical and the importance of the technical aspects of irrigation schemes makes it possible to ignore the human, social and organizational factors in the management of the schemes. This is one of the reasons for the failures of the initial years. But analyses of developmental dynamics in the case studies highlight the importance of the human, social, organizational and political dimensions. Created on already organized and structured spaces, with differing underlying rationales of use, often of extensive livestock husbandry, irrigation schemes exist only as social constructs based on men, spaces and rules. Hydraulic projects (diking of river deltas, polders, etc.) are intended to be vehicles of strong territorial dynamics of development. Even without irrigation, the hydraulic facilities reconfigure, or even want to create, hydraulic territories, but

these territories cannot be solely hydraulic ones. Tensions along the Senegal River or in South Africa have shown the challenges of integrating irrigation schemes into new territories, where water infrastructure will doubtless be dominant but only when used in the service of diversified activities that promote sustainable territorial development. To be successful, such an approach probably requires better linkages between various scales through an improved consideration of local dynamics in national policymaking and by adapting the technical proposals to the diversity of situations.

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Chapter 6

Sustainability of groundwater exploitation in the Mediterranean region

Marcel Kuper and François Molle

Groundwater exploitation is often an extractive activity and therefore unsustainable. In this chapter, we use some examples from the Mediterranean region to illustrate that the sustainability of groundwater is generally subordinated to other socio-political imperatives. These unsustainable practices raise the question of how compatible is the rate of this resource's depletion with the socio-economic transition of the societies concerned, which usually depends, at least partially, on this very resource.

A fatalistic discourse on groundwater overexploitation

Beginning in the 1970s, groundwater use took centre stage, gradually at first and then massively, in different regions around the Mediterranean. The development of technology to pump water without constraints from wells and tube-wells close to farming plots triggered agricultural and territorial transformations. Groundwater began to be widely exploited, mainly through individual initiatives of millions of farmers but also through support by governments in the form of various incentives. Entire agricultural economies based on the exploitation of groundwater sprang up around the world. It is now estimated that 113 out of 300 million hectares of irrigated land in the world use groundwater, consuming about 700 km^3 of water in 2010, which represented 70% of total water withdrawals (Margat and van der Gun, 2013). Approximately 10% of global groundwater used for irrigation is pumped in the Mediterranean region.

Groundwater, stored in the subsoil, has gradually become 'visible' in Mediterranean territories, both within and on the periphery of public irrigation systems and on agricultural frontiers. Its use has led to and become the basis of the introduction of new methods of coordination to derive value from resources (water, land), the adoption of new farming systems and the growth of agricultural markets. These rapid agricultural and territorial transformations are accompanied by strong inequalities in access to water and exclusions. The resulting social fragility is exacerbated by a general decline in groundwater levels (typically about one meter per year) and by frequent

degradation of water quality (salinization, nitrates). Faced with this situation, various countries have adopted water policies for the conservation of groundwater resources, often inspired by the international paradigm of Integrated Water Resources Management (IWRM)[1].

Usually referred to as 'overexploitation', the use of groundwater is often, *de facto*, extractive and therefore unsustainable, with withdrawals continuing until the resource is exhausted. Even though these processes may appear to be the consequence of decisions by individuals, they are, in fact, the result of a coalition of users, managers and policymakers, with the State, too, thus playing a role (Allan, 2007). The coexistence of the rhetoric on the sustainable management of groundwater with these extractive practices therefore raises a fundamental question about the attitude of States. Can it be that the governments grant more importance to other concerns?

Subordination of the sustainability of groundwater to other imperatives

The issue of groundwater use and overuse and the sustainability of its exploitation are usually subordinated to other imperatives. This not only explains the continuing lowering of water tables around the world and the lack of application of the principles inspired by Integrated Water Resources Management, but also provides key insights into the territorial evolution of irrigated territories. For the sake of illustration, we discuss the cases of the highlands of Jordan, the plain of Saiss (Morocco) and the district of Biskra (Algeria).

In Jordan, irrigated agriculture accounts for 46% of groundwater withdrawals. This form of agriculture has spread mainly on the highland plateaus since the 1970s and 1980s, stimulated by export opportunities for agricultural produce, subsidized energy, availability of cheap semi-desert lands, accessible water of good quality, and the transfer of agricultural know-how from the Jordan River valley. While the resulting agricultural growth has been robust, groundwater resources have been severely impacted. In the early 1990s, the government acknowledged the extent of the problem and attempted to strengthen licensing procedures, prohibited the drilling of agricultural wells (1992), introduced water meters (mid-1990s) and imposed a volumetric tariff system (2002). Nevertheless, agriculture continued to expand relentlessly, to 71,000 hectares of irrigated land on the highlands in 2013, compared to just 42,000 hectares in 2000. Despite the very critical situation of its water resources and difficulties in meeting the priority needs of domestic water supply, the State has so far failed to curb

1. According to a common definition of the Global Water Partnership, IWRM is a 'process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.' According to Molle (2008), IWRM – like other 'nirvana' concepts – faces two difficulties: 'it is an attractive yet woolly and consensual concept (nobody is against nirvana). Such concepts typically: a) obscure the political nature of natural resources management; and b) are easily hijacked by groups seeking to legitimize their own agendas. The definition [of IWRM] focuses on the desired three E's (Efficiency, Equity and Environmental sustainability) but implies that they can be achieved concomitantly if – as the word 'maximize' suggests – problem-solving can be informed by neutral and rational approaches, good science and expert knowledge.'

or even stabilize the expansion of irrigated agriculture, and thus the amount of water this activity consumes. This situation may be explained by the economic and political issues involved. First, the political balance of the country is largely dependent on a tribal policy through which the Hashemite regime maintains a give-and-take relationship with the tribes, a key factor in the regime's stability. Second, many wealthy and influential high-level government officials and investors have invested in irrigated farming on the highlands and are loathe to take any decision inimical to their own interests. These interests concern not only agricultural incomes but also land speculation, since land values shoot up once it is developed through agriculture and its ownership eventually regularized. This mechanism also benefits the Bedouins, who are monetizing access, even illegally, to land they claim as their traditional territory (Al Naber and Molle, 2016a). Third, some small farmers are suffering in the current economic climate, and it would be politically unsound to put them under further stress, especially in a post-Arab Spring context (Al Naber and Molle, 2017). Nevertheless, since 2013, the government has been tightening regulations, carrying out awareness campaigns in all concerned sectors and sanctioning numerous offenses, expressing a rare but fragile political will to change the status quo in order to avoid an imminent crisis.

In Morocco, the Saiss plain is located near the imperial cities of Fez and Meknes. This rich agricultural plain has been undergoing a rapid transformation that started in the 1980s, from a predominantly rainfed agriculture (cereals, vines, fodder) to a groundwater-based irrigated agriculture. Nearly 25% of the plain (about 50,000 ha) is currently irrigated with groundwater from the phreatic or captive aquifers, whose levels have been declining for several years. The plain is experiencing major agrarian transformations with the advent of investors who take long-term leases of government land or buy land from former beneficiaries of land reforms, usually to grow fruit trees (apples, plums, etc.). Field vegetable cultivation, mainly of onions and potatoes, has also expanded considerably. These cash crops attract lessees who cultivate up to 100 ha per farm. Field and post-harvest labour requirements have led to widespread employment. The strong growth in fruit and vegetable production in the Saiss is well in line with the country's ambitious Green Morocco Plan, which encourages the intensification of agriculture through subsidies and the easing of regulatory hurdles to access to land and water, which are seen as brakes on production (Fofack *et al.*, 2015). This agricultural dynamic is also essential to maintaining a certain social peace by allowing farmers to continue producing even in the event of drought. Given the political importance of rural territories, groundwater can be seen as a strategic resource whose use in the short to medium term prevails over the issues of its long-term sustainability. To this must be added another factor: the very high profitability of this groundwater-based agriculture benefits investors who have the political and administrative means to protect their incomes.

The Biskra district in the Algerian Sahara is an agricultural frontier in which a rapid expansion of irrigated agriculture has taken place around existing oases since the 1980s thanks to the exploitation of deep groundwater. These groundwater aquifers constitute substantial reserves but are hardly renewable in this hyperarid environment. In Biskra, the area under irrigation increased fivefold, from 16,615 ha in 1969

to 83,350 ha in 2008, with 94% of irrigation water sourced from groundwater (Kuper *et al.*, 2016). The main crops are the date palm (primarily the famous *Deglet Noor* variety), greenhouse and open field vegetables, fruits, and cereals. The State has played a very important role in the rapid development of this agriculture, first by drilling deep boreholes to provide additional water to farmers during the droughts of the late 1970s and then by providing substantial subsidies for drilling boreholes or planting crops. It has also created infrastructure – roads, markets, electricity grids, public utilities – to support this agricultural system (Amichi *et al.*, 2015). Finally, the State has chosen not to implement regulations concerning tube-wells very strictly. Indeed, some tube-wells in use are not registered. An impressive development followed with a population growth rate of about 5% between 1987 and 2008, unlike most other rural areas in Algeria. This territory is thus a good illustration of the State's goals to integrate Saharan areas with national territories in order to make the Sahara a 'hinterland vehicle and vector for economic development' (Kouzmine *et al.*, 2009). Groundwater is considered here in the same way as oil reserves, as a resource useful for the development of the country's Great South region, which is happening at the expense of, but also because of, these essentially non-renewable resources.

The challenges of collective management of the groundwater resource

These three case studies (which could be supplemented by similar examples from Tunisia, Egypt or Yemen) show the social, economic and political importance of groundwater use in the Mediterranean, thus complicating the key issue of this resource's sustainability and exploitation. Groundwater management is not perceived as a crucial issue by the actors of the territories we have described in this chapter. It is therefore not surprising that they do not address it explicitly. Some observers believe that the use of groundwater in this unsustainable way by a determined coalition of users, managers and policymakers will ultimately be short-lived, even if groundwater would have by then facilitated a socio-economic transition (Allan, 2007). However, this raises the question of how compatible is the rate of this resource's depletion with the rate of socio-economic transition of the societies concerned. Some researchers, such as Tushaar Shah (2009), are optimistic. He posits that in India groundwater will generate a surplus needed to educate the children of irrigating farmers, allowing them to make a living elsewhere. At a more regional level, this also raises the question of the quantitative sufficiency of food production and the induced impact on the prices of these commodities. Finally, the current decline of the groundwater resource often leads to exclusionary processes and a concentration of the resource on capital-intensive farms.

While the processes underway in Mediterranean rural areas are of global concern, they must be analyzed on a case-by-case basis since hydrological conditions and social realities vary from one context to the other. The territory seems to be a suitable scale for finding a balance between a legal framework inspired by 'good' international norms and current unsustainable practices via a process of negotiation involving public and private actors. This is what is being attempted in several countries by

some recent initiatives that emphasize collective and concerted access to resources, in particular through management by associations of groundwater users (for example, in Tunisia, see Frija *et al.*, 2016) or by irrigation cooperatives (in Turkey), or through aquifer contracts (for example, in Morocco). These initiatives deserve to be studied and supported in order to highlight the common-property nature of groundwater resources and to bring about change in current dynamics.

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Chapter 7

'Municípios Verdes': from zero deforestation to the sustainable management of natural resources in the Brazilian Amazon

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The Brazilian federal government's Action Plan to Prevent and Control Deforestation (PPCDAM) in the Brazilian Amazon[1], launched in 2004 and backed by commitments by the soya bean and beef sectors, has led to a considerable drop in the annual rate of deforestation. For territorial actors, it has been a matter of conceiving, planning and implementing a rapid agrarian transition, based on a more efficient management of their various natural resources, of appropriating a limited physical space, and of creating the institutional capacities required to manage it sustainably.

The *Município Verde* initiative

Starting in 2008, the Brazilian federal government's coercive measures against deforestation have targeted specific *municípios* (municipalities), on the basis of three indicators reflecting the intensity of deforestation. One of these targeted *municípios*, Paragominas, which covers an area of 20,000 km^2 in Pará State, launched the Município Verde (Green Municipality) initiative in 2009. Paragominas was previously known for widespread extractive and mining exploitation of its natural resources. Public- and private-sector actors of this municipality, supported by environmental NGOs and funds from large companies located in the region, proposed a territorial

1. This chapter is based on research carried out within the framework of the Ecotera project, funded by the French National Research Agency (ANR-13-AGRO-0003).

pact with key shared objectives: the end of deforestation; the registry of landholdings; incentives for restoration or reforestation of degraded soils; and the adoption of good agricultural, livestock and forestry practices. In two years, the rate of deforestation in Paragominas has fallen below 40 km^2/year and the land registry has been completed for more than 95% of the territory, achievements that led to the suspension of federal punitive measures against the municipality. This emblematic success of the initiative inspired the Municípios Verdes Programme, launched by the government of Pará State. A total of 107 *municípios* (out of 144 for the whole state) have so far joined this programme. This programme has adopted the main objectives of the Paragominas initiative. However, it exhibits several limitations jeopardizing the sustainable management of natural resources in a zero-deforestation future.

A pact and alternatives not adapted to family farming

In Paragominas, deforestation has decreased considerably in medium and large farms but much less so on family farming land (Piketty *et al.*, 2015). Not only does deforestation resulting from traditional slash-and-burn practices still persist, it has even increased for some cash crops. Alternatives (provision of a tractor to clear the plots without using fire) or measures to consolidate family farming have been proposed, but they still benefit only a small number of farmers close to the city (Viana *et al.*, 2016). Furthermore, a more efficient use of key natural resources, such as soil fertility and water resources, is not part of these measures and not actively advocated. Thus, soil conservation techniques are still rarely implemented, even though they are essential to the viability of agriculture that does not require forest clearing or the use of fire. In addition, the new, more demanding, environmental and health standards are tending to weaken family farming (Piraux *et al.*, 2015).

Disrupted forest functions

Different land uses in the territory of Paragominas since the 1960s have led to a mosaic of forests in very different states. Cleared but uncultivated areas have been replaced by so-called secondary forests of varying ages. Primary forests, which cover 54% of the territory, are, for the most part, degraded (Bourgoin *et al.*, 2016). Their structure, functions and ecological services are very different from those of mature forests (Berenguer *et al.*, 2014). It has now become necessary to manage these degraded forests because a zero-deforestation commitment makes them a permanent component of the territories. Reflection at the territorial scale is required to make agricultural production compatible and spatially complementary with forest production so that fragmentation can be limited as far as possible and a forest matrix can be maintained. Finally, there is very limited knowledge about the processes behind forest degradation, and research is needed to better characterize them, locate them in the landscapes, and identify land use plans that favour the conservation of the services that these forests can provide (Ferreira *et al.*, 2015). The dichotomy between forests and non-forests, which underpins deforestation monitoring systems, and measures focusing solely on zero-deforestation are clearly not sufficient to confront these challenges.

The need for more efficient management of the various natural resources

Farmers are all aware of the need to intensify land use and adopt practices that are less detrimental to natural resources. However, most available techniques aim to increase productivity per hectare without really considering the functioning of the agroecosystem as a whole. Furthermore, they often require the use of equipment or inputs that are too expensive or technical for most farmers (Cialdella *et al.*, 2015). These forms of intensification result from individual farmer strategies (Poccard-Chapuis *et al.*, 2015a) and are mainly found on the most fertile and accessible land (Piketty *et al.*, 2015). Agricultural practices that make better use of the functioning and complementarity of the different natural resources do exist and some are already being tested by innovative farmers. They are inspired by the principles of agroecology, with, in particular, the emergence of agroforestry systems or the spatial reorganization of the farm (rational management of pastures and reservation of areas far from buildings for forest regeneration on the basis of soil quality, topography, etc.). These various practices often take more time to start producing economic returns and they remain sensitive to the risk of accidental fires. Collective action and the mobilization of territorial actors (action research, technical support, communication) are thus necessary for their adaptation and dissemination (Poccard-Chapuis *et al.*, 2015b).

How to proceed further?

In order to proceed further in the sustainable management of natural resources, a territorial development project has to emerge from a greater involvement of actors, especially those from family farming. The challenge is to 'make' the municipality of Paragominas a territory, i.e., the actors have to appropriate it (through a more detailed knowledge of its resources), organize it more (by establishing rules and creating suitable governance mechanisms), and then implement, in concertation, their territorial development project. Measures to accompany local experiments, the production of detailed cartographic data on the monitoring of practices and of their impacts on natural resources, and the prospective scenarios currently built with local stakeholders in Paragominas seek to help address this challenge.

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Chapter 8

The territory, at the heart of new fish-farming innovations

Olivier Mikolasek, Marc Oswald, Newton J. R. Da Silva, Lionel Dabbadie and François Henry

The extension of fish farming is rarely considered at a territorial scale. This chapter focuses on a conceptual framework used to mobilize the resources of a territory for devising new fish farming innovations. Starting from an initial formulation developed in Brazil to interpret differences in territorial fish farming trajectories, this framework will be applied to fish farming realities of West Africa. The competitive advantages of a territory depend fundamentally on its ability to construct an innovative productive organization – the local innovation system – that relies on the local specificities of the biophysical, social, economic and institutional environment (Bureth and Llerena, 1992). The local innovation system is the result of interactions between four hubs of expertise: production, science, training and funding. A specific component of the innovation process is associated with each of these hubs. Production is associated with learning, which is the acquisition of knowledge and know-how by an individual or a group; science with research and development if its priority is to produce knowledge oriented towards the resolution of production system bottlenecks; and training with impartation of skills to producers. As for the funding hub, it encompasses the evaluation process which validates and orients the choices of the technologies to be developed. To be truly effective, public action must incorporate three of these four hubs of the local innovation system: science, training and funding.

The local innovation system is considered to be the nucleus of the socio-technical network of fish farming (Da Silva *et al.*, 2009). It is constituted by individual and collective entities defined by their identities and their projects, linked to each other within a territory (Callon, 1986). The network is consolidated by expansion through translation operations (Figure 8.1) undertaken by an individual or institution. The translation aims at reconciling the statements of different groups of actors and, in particular, to resolve controversies in order to facilitate the construction of the fish farming innovation being promoted by the emerging network.

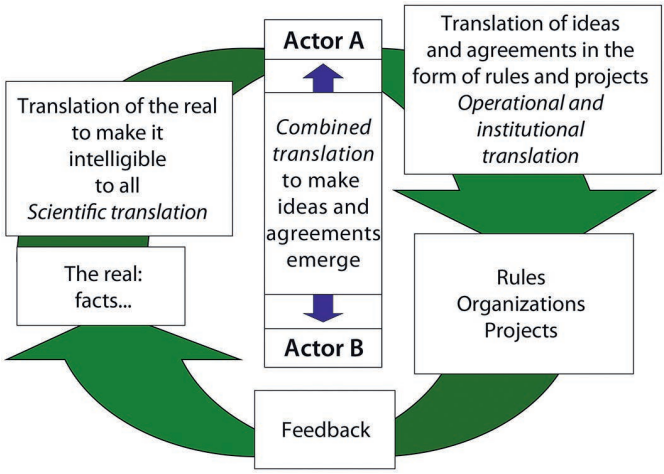

Figure 8.1. Translation cycle (Beuret, 2006).

Comparative approach to fish farming developments in Brazil

The study by Da Silva *et al.* (2009) found that the dynamics of fish farming in the Ribeira valley in São Paolo State are not as strong as those of the upper Itajai valley in Santa Catarina State (Table 8.1).

Fish farming was introduced in the Ribeira valley by Japanese immigrants in 1931. From 1984 to 1989, the State provided technical assistance, distributed fingerlings and made often irrelevant investments, such as a fish filleting factory that was still unused in 2013. In spite of this diffusionist approach, a local innovation system emerged in 1990 in Juquia municipality. A fish farmer, who had earlier been a technician-researcher, proposed a fish farming project which obtained the support of the mayor. A research unit was set up. The sector began acquiring structure. As early as 1991, a food factory located outside the territory began experimenting with making extruded food for use as fish food. The translator was this fish farmer at the heart of the local innovation system. From 1992 to 1997, the network lacked coordination and there was little proximity between the actors: sales took place outside the territory, the extruded food was made in distant cities, and the fingerlings produced in north-western Brazil were shipped in by air. Technical advice was provided by fish-food vendors who had no link to the network or its territory. The researchers conducted research without involving the network and, after 1996, the local research unit sputtered to a halt. From 1998 to 2003, the network gradually imploded. Leaders of the sector turned into fingerling traders, especially since the market had become increasingly less favourable. This situation persists until today.

In the upper Itajai valley, immigrants, mainly of German origin, started carp fish farming in 1920, introduced from back home, as a subsistence activity. In 1986, a technician from the government's research and development agency proposed a model that integrated pig and fish production. In 1994, a local innovation system

Table 8.1. Comparison of the development of the dynamics of fish farming in the Ribeira valley and the upper Itajai valley.

Characteristics	Ribeira valley	Upper Itajai valley
Land use and occupation	Indigenous population, Japanese colonization, various investors	German and Italian colonization, family farming
Territorial resources	Exogenous: extruded foods	Endogenous: pig droppings
Type of controversy	Mild: external to the territory – political Consequence: fish farming diffusionist project (1984)	Strong: internal to the territory – environmental Consequence: Establishment of rules to practice the activity (1997)
Translator	Fish farmer	Extension agent World Bank mission
Local innovation system	Juquia municipality in 1990	Agrolândia municipality (1994-1998)
Training hub	Initial training, then technicians of food manufacturers	Learning and extension agents
Research hub	Presence of a research unit Action external to the network	Research on the farms Action within the network
Funding hub	Priority for infrastructure	Funding for training and research and development
Production hub	Weak organization of producers Relationships related only to market opportunities	Strong organization of producers Relationships of cooperation, trust and market

Based on Da Silva *et al.*, 2009.

emerged in the city of Agrolândia around his activities. It was supported by the town's administration. Agrolândia producers came together in the harvesting of fish and local industrialists integrated the sector in their activities (fingerling producers, fish producers, and fish processors for the local market). In 1997, this system was blamed by an NGO that claimed that the integrated pig/fish production was leading to a proliferation of mosquitoes. In response, various actors mobilized themselves (World Bank, municipal councillors, mayors, technicians, researchers, fish farmers, NGOs), initiating a translation process. Rules were formulated to regulate fish farming practices that were acceptable to the NGO. From 1993 to the present day, Agrolândia's local innovation system is being consolidated through dissemination and replication in a large number of the region's municipalities.

Realities of sub-Saharan Africa: the case of Guinée Forestière

In Guinée Forestière (Forested Guinea), the technical reference framework was transferred from the lessons learnt from West-Central Côte d'Ivoire (Oswald, 2015). From 2002 to 2008, in several villages in Nzérékoré prefecture, the local innovation system took the form of a network of fish farmers' groups who maintained close links with the project leaders and managers. The latter encouraged scientists to get involved and facilitated frequent exchanges with administrators and financial institutions (Box 8.1). Experienced farmers from these villages subsequently helped other fish farmers get started after the project ended.

The local innovation system here has been able to derive value from the territory's own resources, i.e., the numerous lowlands used for fish farming and the know-how in rice cultivation, by profitably associating fish farming with flooded rice cultivation. The recent introduction of palm kernel crushers has made palm kernel cake abundantly available as animal feed, a development that has encouraged the establishment of pig farming and its integration into fish farming (Rangé *et al.*, 2015). Based on these dynamics, the network is being further strengthened since 2012 under the impetus of a new project, the Rice-Fish Farming Development Project in Guinée Forestière (2012-2017), and is now participating in the role of translator within this local innovation system. The project's actions are stimulating professional proximity within the network, which now includes more than 1500 agro-fish farmers, numerous local village groups and a professional organization, the regional federation, which is backed by unions in a few districts.

Recently, a controversy erupted regarding the use of exogenous but selected breeding strains, leading to a different organization of reproduction. This can be a threat or an opportunity for the network depending on how the federation, the project and government will resolve the controversy.

Box 8.1. Project intervention strategy in Guinea.

The Fish Farming Project in Guinée Forestière (1999-2008) benefited from AFD's support. The National Aquaculture Directorate, the contracting authority, has a mandate to evaluate fish-farming activities.

Implemented by APDRA – Pisciculture Paysanne (www.apdra.org), the intervention strategy is based on the men and women in farmer families, who mobilize their know-how, skills and labour, and their ability to take initiatives and assume risks. In return, the programme provides the technical information and expertise necessary – easily appropriated and with low investment cost – for setting up fish farms in the lowlands. A training and support system destined for voluntary producer groups disseminates this technique.

Several elements contribute to the emergence and consolidation of the socio-technical network:
– the participation of all families since no investment subsidies are available, the management of the ponds being undertaken by the fish farmers;
– grassroots groups, which are the driving force behind a dynamic of local innovation, make training more accessible, facilitate exchanges, gradually lower the training costs of the fish farmer and structure the sector (Grosse and Oswald, 2010);
– the integration of the association of fish farming and flooded rice cultivation into local agricultural production systems does not compete with the farming calendar of other agricultural activities (Simon and Benhamou, 2009);
– access to a large local market, with fish making up the bulk of animal protein intake in this region.

The projects' actions gradually strengthen the autonomy of the local fish farming groups which provide the main functions of facilitation, coordination, training and support.

Figure 8.2. Large and completely transplanted rice-fish farming pond.
The monk sluice can be seen in the background and, on one side, a pigsty (Gbotoÿe, Prefecture of Nzérékoré, Guinée Forestière).
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Figure 8.3. Integration of flooded rice cultivation and fish farming.
The fish farmer will soon begin to raise the water level in his pond – while ensuring that the top of the rice is above the water – to simulate a flood. We can see the service pond where the fish for restocking is kept (Gbotoÿe, Prefecture of Nzérékoré, Guinée Forestière).
The local innovation system has been able to derive value from the territory's own resources, i.e., the numerous lowlands used for fish farming and the know-how in rice cultivation, by profitably associating fish farming with flooded rice cultivation.
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Conclusion

The fish farming network manages the territory's resources in a wide-ranging manner: design of efficient fish farming facilities, appropriate choice of fish species, abundant supply of inputs, implementation of fish farming practices recognized as high-performance, identification of accessible markets, innovative ways of organizing and, more broadly, a body of specific expertise and know-how.

However, the example of Brazil shows that the sustainability of these local dynamics depends on their recognition by the State. The consolidation and expansion of the local innovation system constitute a same continuous process that draws its resources from the territory but can be weakened or threatened by an external entity (example of extruded food in the Ribeira valley) if it does not incorporate the network. In Guinea, the production hub, acting through local groups, has been able to prolong the growth of fish farming beyond the duration of projects. However public actions that rely on international funding do not seem to be able to integrate the three other hubs of competence of the local innovation system, despite the support of the national directorate of fish farming (Halftermeyer, 2009).

The agro-fish farming territory thus exists as a space for managing resources whose characteristics, including geographical boundaries, are shaped by its history, the local innovation system and its expansion supported by public action. This requires national policies that are able to take the competitive advantages of these agro-fish farming territories into consideration. An interface between the representation of a territory's fish farming profession and State services, and a balanced dialogue between all stakeholders would facilitate this desired evolution.

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2-2 – Organizing the territory for production

Chapter 9

Dissemination of improved crop varieties in Africa: how territorial partnerships ensure the success of innovations

Danièle Clavel, Gilles Trouche, Louis-Marie Raboin and Kristen vom Brocke

The level of adoption of improved food crop varieties remains low in sub-Saharan Africa (Yapi *et al.*, 2000), a situation that must be viewed in the light of existing seed production and exchange systems. These informal but dominant systems are diverse and resilient (McGuire and Sperling, 2013), and concern improved, traditional and even local varieties. This situation is a result of multiple factors and varies according to contexts (countries, regions and species involved, actors, policies, etc.). Some leading causes include the poor suitability of proposed improved varieties to cropping systems and the needs of smallholders; the lack of smallholder knowledge about these new varieties; and the poor implementation of centralized State schemes for the production of so-called certified seeds (Louwaars and de Bœuf, 2012; Clavel, 2016). Informal rural systems for the selection, production and exchange of varieties and seeds are increasingly being overlooked. However, some programmes of varietal development and/or production and of dissemination of seeds of improved varieties, conducted in close partnership with farmer organizations or groups, and deeply rooted in the territories concerned, show that it is possible to increase the rate of adoption of improved varieties considerably.

In this chapter, we analyze the conditions that are conducive to varietal innovation from three case studies. Three varietal improvement programmes – groundnut in Senegal, upland rainfed rice in Madagascar, and sorghum in Burkina Faso – were conducted by plant breeders and agronomists with a significant involvement of farmers and other development actors. An *ex post* evaluation was carried out within the framework of CIRAD's 'Impact of Research in the South' programme (Impress, http://impress-impact-recherche.cirad.fr/), based on a participatory approach that included surveys of key actors and beneficiaries. These studies are characterized by their observation over the long term of the development of varietal and seed innovations: since 1984 for rice (Raboin *et al.*, 2013, 2014), 1999 for groundnuts (Clavel *et al.*, 2013) and 1995 for sorghum (vom Brocke *et al.*, 2010).

The research and development activities evaluated took place in contexts that were always evolving and which were marked by irregular funding and discontinuous human resources. Researchers involved in these studies are plant breeders embedded in territories they know well in terms of ecogeography and actors. Although ascertaining the social impact was not an explicit goal, impact assessments as part of the studies identified the major drivers of the success of innovations and explained the role that research played in the changes (Table 9.1).

How have territorial links contributed to the impact?

The role of the research community has proven to be decisive through the creation and maintenance of a solid institutional and territorial partnership, and through training activities it has organized. Peer-to-peer exchanges between farmers have played an important role in all three cases in the dissemination of varieties, the acquisition of technical skills, and in the organization of seed production. In the case of groundnuts, the model of the local seed cooperative has been replicated in other regions and has subsequently encompassed other food crop speculations such as millet, sorghum and maize. In the case of rice, geographical proximity was crucial as the numerous trials conducted in rural areas and the demonstrations conducted increased opportunities for dialogue and learning. The development of individual, collective and institutional skills was probably the main factor that allowed a real structuring of the seed sector taking into account the needs and expectations of sorghum farmers in Burkina Faso.

Research and training activities, by virtue of being anchored to a territory, participated in its construction. Indeed, they brought together various actors in common spaces. Furthermore, because they are inherited and passed on, seeds possess a heritage value and, in this way, contribute strongly to a territory's identity (Labeyrie *et al.*, 2014). It is therefore not surprising that actors of a given territory willingly invest themselves in varietal innovations.

Partnerships in agricultural development projects often have a limited lifetime, as public funding mechanisms do not ensure seamless funding from one period to the next, resulting in discontinuities and bottlenecks. The acquisition of new capacities by farmers and their collectives (experimentation with and evaluation of varieties, production of quality seeds, collective organization) and the creation of partnerships with the research community over the long term help compensate, at least partially, for any shortfalls in funding and/or the departure of any particular actor in the course of the innovation's development. Experience has shown that if a new variety meets the expectations of producers, informal farmer-to-farmer dissemination always occurs, and the role of the research community becomes gradually less obvious. Varieties disseminate better when the actors' innovation capacities can help them form partnerships that are essential to a greater impact. The observed up- and out-scaling have taken different forms, but we consider that the success of the innovations depend on the identification of actor-partners and the facilitation of their interconnection in such a way they will able to participate from the initial phases of the project and in its deployment. This is, indeed, a major challenge for the research community, one that can be largely addressed by leveraging territorial links.

Table 9.1. Main results of the impact assessments in the three case studies.

Case study	Groundnut in Senegal	Rice in Madagascar	Sorghum in Burkina Faso
Context	Groundnut is both the main income source and forage plant. Its usefulness as food is growing. The structural adjustments of the 1980s liberalized the sector and, in 2002, led to the dismantling of State-owned enterprises Sonacos and Sonagraines, thus disrupting seed collection, marketing and production.	The highlands are densely populated with limited possibilities for infrastructure for irrigated rice fields. Land pressure is high and food security remains uncertain. It is not possible to grow rainfed upland rice due to the lack of suitable varieties adapted to altitudes greater than 1300 m.	Sorghum is the staple food of rural populations, especially in the driest areas (annual precipitation < 800 mm). While varietal improvement programmes were launched in the 1960s, the adoption rates of varieties and the availability and use of improved seeds remains low.– There is a need to increase yields and regularity of production.
Research objective and description of the innovation	Interpreting the new varietal map (area-wise distribution of improved varieties) in terms of the organization of seed production without State support. Design of a cooperative model for the production of quality seeds and groundnuts (without aflatoxins).	Creating new varieties for upland rainfed rice cultivation (since 1984). Improving self-sufficiency in rice for highland smallholders. Varieties are created by cross-breeding and selection in high-altitude experimental stations using low-input cultivation systems.	Developing high-yielding varieties through participatory breeding (PB) in rural farming systems that are adapted to the use of grains and straw in two agro-climatic zones of the country (West and Centre-North). Seven new varieties were created and new methods of seed dissemination were developed.
Building of the partnership	Research community + producer organization + local committee for coordination of farmer organizations active in Paoskoto village. Coordination for setting up partnerships involving donors (EU and WB) from the start. Research community and producer organizations act as brokers to facilitate partnerships with entities outside the initial core group (certification agencies, banks, private sector).	A large number of trials were undertaken in farmers' fields with different partners (farmer organizations, development projects, NGOs and research and education institutions) to evaluate varieties in a participatory manner. Peer-to-peer distribution from the various trial locations.	Innovation development phase: research community + region-wise producer organizations + network of farmer-breeders. Innovation dissemination phase: research community + same producer organizations + networks of seed producing farmers and other public and private development actors.
Training and capacity development	Decentralized collective training with respect to the development of the model cooperative and quality production. Professionalization training (production techniques, management, marketing).	Trainings of technicians of partner organizations through trials in farmers' fields. Training of farmers through exchange visits, open houses, extension documents with or without the support of the research community by partners.	Training on varietal testing in smallholder farms, participatory breeding methods, production, packaging and marketing of seed, initially designed and implemented by the research community, then adapted by producer organizations.
Factors contributing to the perpetuation and extension of the innovation	Setting up in the territory of the model cooperative and subsequently of 28 other cooperatives. Increased capacity of producer organizations to defend the interests of the groundnut sector, in particular by mobilizing fresh funding. Extension of the certified-seed cooperative model to other species and to other African countries.	Strong demand for rice and the opportunity for growing rainfed upland rice seized by researchers and farmers. Establishment of local farmer networks for varietal assessment. – Continued presence of the research community since 1984 and a long-term and ongoing partnership with development companies established in the region for the production of certified seeds.	Continuity of several research projects in the same territories and with the same actors over a period of 15 years. Willingness of researchers to support producer organizations even up to the stages downstream of varietal creation. Improved recognition by the two producer organizations of the links existing between agricultural production and development of their territories. Actions by public entities favourable to dissemination of improved varieties.

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Chapter 10

Creating innovative sectors in a territory for deriving value from biomass: Valosorgho in Occitania, an ongoing project

Sophia Alami and Danièle Clavel

An unprecedented challenge

The use of sorghum biomass can form the basis of a potentially innovative sector that can generate economic value and employment in a territory. The ongoing project, Biomass For the Future (BFF)[1] (Inra, 2012-2019), is working on varietal and technological solutions for deriving value at an industrial scale from sorghum biomass. The strategic approach adopted, through the Valosorgho concept in Occitania, originates from a desire for the territorialization of the BFF project.

To this end, we adopt a pragmatic approach in which action fuels reflection, and conversely, in which a constant dialogue is maintained with the reality of the situation. The approach is all the more novel as the targeted territory (Occitania) is itself being formed within the context of the recent mergers of French administrative regions. Occitania is the leading sorghum producing French region. The sector's territorial anchoring is therefore essential, and its creation was the challenge entrusted to CIRAD in the form of a specific mission. This chapter presents our progress in this regard.

From the 'Biomass For the Future' project to Valosorgho

Numerous experiments have shown that technology and social processes must be considered together for an innovation to be sustainable. A partnership for innovation is thus based on the hybridization of knowledge and practices (Hatchuel, 1994), as well as on the co-production of knowledge.

1. BFF, http://www.biomassforthefuture.org/ (retrieved 14 November 2016).

The proposed approach relies on a theoretical framework derived from pragmatic reflection and pertaining to management and sociology (Dumez, 2007; Callon, 2013). The principle is thus based on creating interactive partnerships at a territorial scale. However, no off-the-shelf method currently exists to form such partnerships. We have thus deployed a pragmatic and participatory method based on territorial engineering. The principles of the approach are: a transdisciplinary theoretical framework supporting a functionalist global vision (each segment having its own non-hierarchical function); deriving value from the action (in interaction with the 'theory'); and leveraging knowledge generated from the practice.

We use a model of interactive innovation that depends, starting from its conception, on the characteristics of the territory and the expertise of its actors. This 'open' innovation model is being promoted by the European Innovation Partnership (EIP) initiative, which advocates networking of actors as an enabling factor for the appropriation and sustainability of agricultural innovation (Centre d'étude et de prospective, 2013). Bottom-up, systemic (non-linear) and not centred on the transfer of any particular technology, the model takes into account the specific context and the contribution of different actors of the value chain through a socio-economic, territorialized and non-segmented vision. According to Leeuwis and Aarts (2011), it is this contribution in the form of a 'collective process' that guarantees successful changes of the scale of the innovation, in particular those that address territorial development issues.

Territorial engineering has consisted of creating an arbitrated and coordinated dynamic of actors that offers ample room for concertation between actors, also called 'territorial engineering chain' (Trognon, 2013). The function of innovation brokerage, as defined by the European Innovation Partnership, is crucial. It consists of implementing territorial engineering, through what has been described as 'acting together' (management, project administration, etc.), and through transparent and accurate documentation, facilitation, mediation, interpretation and building of links between different skills, know-how and scientific disciplines (Callon, 2013; Trognon, 2013).

This approach, whose current status is shown in Table 10.1, corresponds to an intervention framework called 'Valosorgho', recognized as a structuring project by the new Occitania administrative region. The network of actors concerned includes private companies, local authorities, decentralized State services, chambers of commerce and agriculture, cooperatives, research institutions and competitiveness clusters. The participatory process has led not only to the structuring of the value chain but also to the emergence of a shared rationale for promoting sorghum cultivation, based on global warming imperatives, especially water scarcity (Alami *et al.*, 2016).

Dissemination and application of the Valosorgho model

The proposed participatory model experiments with new research practices in which the quality of the multi-actor partnership is a key factor in terms of operability and evolution capacity, especially in the context of the agricultural sector. This capacity building renews territories (Torre and Wallet, 2013) by triggering collective

Table 10.1. Current status of the Valosorgho approach in Occitania.

Aims and objectives	Developments and achievements	Future perspectives
Analysis of the existing system of actors, specificities of the territory, opportunities, policies	Mapping of the actors' system and the innovation ecosystem Compilation of actor perceptions (40 interviews)	Emergence of a collective territorial intelligence: 'sorghum in Occitania'
Participation of actors	Building of a multi-actor network; co-construction of a common rationale and vision of the value chain	Value chain model 'sorghum in Occitania'
Institutional and political anchoring	Valosorgho is recognized as a structuring project for Occitania and is part of the regional innovation strategy[1] in line with the orientations of Ademe (The French Environment and Energy Agency).	Support for the mobilization of regional funding (ERDF, etc.). Integration of pilot projects in the region: ClerVerts circular economy project in Lauragais
Academic and technical anchoring	Involvement of 15 laboratories and technical institutes; technical platforms	Joint response to calls for research and development projects (Ademe, etc.)
Anchoring of the innovation in the ecosystem	Association with competitiveness clusters and private companies	Labelling by the 'Agri Sud-Ouest Innovation' cluster
Structuring and activating the R&I process	Mobilizing funding for work on validation of technologies and technical itineraries ('proof of concept')	Submission to regional collaborative research and development calls (CFPs) Emergence of cost-effective value chain models Innovative agricultural production systems
Multi-actor network facilitation	Creation of an operational multi-actor group 'ValeurSorgho' that brings together 16 stakeholders	Recognition or labelling of the group of actors Raising funding for facilitation (e.g., rural development programme CFP[2] 'Territorialized sectors'), etc.
Dissemination in Europe	Poster presented at the 1st European Sorghum Congress (Bucharest, November 2016)	Participation in the 1st European Sorghum Congress (Bucharest, November 2016); constitution of a focus group, response to CFP H2020 'Thematic Network'
Dissemination at the international level and in countries of the Global South	Presentation of the Valosorgho approach at the Global Conference on Agricultural Research for Development[3] (Theme: 'Scaling up from research to impact')	Expansion of the model in countries of the Global South, in particular in Africa: a new CIRAD-led collective action for anchoring research in interactive innovation systems Dissemination of the approach *via* the Biosorg[4] project, DP IAVAO[5] and inter-African programmes

1. Regional innovation strategy (European policy priorities in the region).

2. Rural development programme financed by the European Agricultural Fund for Rural Development (EAFRD).

3. Global Conference on Agricultural Research for Development, 3rd Global Forum on Agricultural Research (GFAR), Johannesburg, April 2016.

4. 'Gaining mastery over sorghum-based food products', Agropolis foundation, involving the Institute of Rural Economy (IER) in Mali as a partner.

5. Mechanism for research in partnership of CIRAD 'Innovation and Varietal Improvement in West Africa'.

intelligence as well as various achievements. In this process, it is no longer a matter of technology transfer but a matter of collectively built territorial, cognitive and disciplinary integration.

The approach and the methodological reflection go well beyond the framework of Valosorgho in Occitania. Research conducted must benefit partners from the countries of the Global South, i.e., situated in their contexts and adapted to their specific constraints. The implementation of such innovation platforms is on the agenda in Africa, for example in the Comprehensive Africa Agriculture Development Programme (CAADP), which has been implementing multi-actor partnership platforms for several years. CIRAD's system of research in partnership in countries of the Global South also provides excellent platforms to implement and share this approach that combines experimentation and learning in a territory to support the emergence of innovations in the agrifood sector at the same time as encouraging social transformations.

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Chapter 11

Co-designing cropping systems and territorial planning

Oumarou Balarabé and Olivier Gilard

The process of co-designing cropping systems consists of participatory development of crop combinations or their successions on the plot, or of technical itineraries optimized for sustainable productivity. Actors participate in the design process through:
– developing and taking into account a participatory diagnosis that will help formulate new technical proposals;
– the involvement of farms in the adaptation phase of technical innovation, in keeping with their own constraints of access to resources and production factors;
– the involvement of all actors in defining new institutional mechanisms to facilitate the dissemination of innovative cropping systems.

From managing fertility to co-designing cropping systems within village territories

Historically, the design of cropping systems has represented a path of innovation that involved technical modifications at the level of the cultivated plot. It was progressively subjected to adaptations at first the farm level and then at the village territory level, in order to accommodate the diversity of situations and constraints at these two complementary scales (Le Gal *et al.*, 2011).

The introduction of agricultural mechanization in sub-Saharan Africa in the 1970s and 1980s led to problems of erosion and lowered fertility of soils. Sustainable soil management initiatives adopted to address these problems initially focused on managing village terroirs[1], with particular emphasis on the need to integrate farming and livestock activities. Subsequently, innovative cropping systems were developed – technical packages tailored to the size of the cultivated plot – resulting in profound changes in the organization of village territories (Balarabé *et al.*, 2012).

1. Concept that corresponds to a village community and its space, and where production of livestock and other natural resources predominate.

The co-designing of cropping systems as a lever for territorial transformation

The co-designing of cropping systems is based on a preliminary analysis of physical and human environments. The characterization of the physical environment (climate, soil types, water regime, etc.) aims to identify, with the actors concerned, transferable technical solutions (cropping systems) capable of addressing the environment's constraints. A diagnosis of the human environment (socio-cultural organization, typologies of farms, sectors and markets, etc.) is necessary to understand collective constraints in relation to the context. This diagnosis is a prerequisite for setting up a concertation framework (or arenas for innovation) in which local actors can discuss institutional arrangements that complement the adoption of innovative cropping systems. It thus appears that if we start with a process of co-designing of cropping systems, the territory can be modified by new institutional arrangements between actors.

The conception of cropping systems, as it relates to crops and technical itineraries, thus appears to be an element of transformation and planning of the village territory. It is as if the planning of village territory – at one time achieved through a concerted management of the territory and its resources (purely organizational innovation) – is triggered by a technical innovation which, through the organizational and material changes produced, results in a modification of landscape elements.

Concerted land planning as a prerequisite for co-designing cropping systems

The adoption of soil conservation practices is confronted by a key problem of divergence between the private interests of actors and the collective interests of society. In developing countries, this divergence is exacerbated because property rights pertaining to the land and its produce are poorly defined. In Sahelian regions, where agricultural lands are common resources, concerted planning of rural spaces and natural resources is a prerequisite for any innovation affecting the organization of agricultural and livestock activities.

Such is the case in pastoral areas in Niger and Burkina Faso, where endogenous rules have defined pastoral areas – including paths to access them – and modalities of transferring fertility between agriculture and livestock breeding activities, thus paving the way for promising technical innovations such as forage production. In general, a concerted planning of agro-pastoral territory necessitates the provision of the following within the common space:

– spaces reserved for feeding herds (agro-pastoral area);
– area for penning livestock (pastoral areas) and cattle tracks;
– agricultural spaces, with defined allocation of residues (*in situ* conservation or for other use).

This organizational innovation has to precede the dissemination of innovative cropping systems that make up the technical innovation component (Ruttan, 2006).

This collective management of the territory, involving the design of innovative cropping systems, has the dual objective of increasing the total productivity of the resources produced (e.g., crop biomass) and of optimizing its use between the different actors in the territory.

Box 11.1. Case study: co-designing direct seeding and mulch-based cropping systems and management of territories in North Cameroon

Conservation agriculture is based, at the same time, on three principles:
– minimal tillage;
– maintenance of a permanent cover;
– appropriate crop associations and rotations.

These principles together contribute to biological soil management, and ensure ample crop productivity and conservation of the soil capital (Séguy *et al.,* 2006).

In the cotton-growing areas of North Cameroon, co-designed cropping systems in conservation agriculture exhibit a wide range of variation depending on the agro-ecological environment, the types of farming and the local collective organization. They include forage mulch-based cropping systems, degraded-soil restoration cropping systems, low-fertilizer cropping systems, and so on.

In the process of co-designing cropping systems in North Cameroon, a specific concertation approach within pilot terroirs, based on agro-pastoral diagnoses, took the diversity of territorial dynamics in the area of intervention into account. Thus, for example, in the agro-pastoralists's terroir in Sirlawé, the fields surrounding the village, traditionally used for continuous cultivation of cereals and for livestock penning, were converted into forage cultivation in association. The other surrounding lands, whose fertility declines as the distance from the village increases, were used for conservation agriculture tailored to restore degraded soils. A concerted planning of the territory enabled space distribution and livestock movement over time.

In the terroir of Laïndé Massa, where sedentary livestock breeders and farmers coexist, the co-design of cropping systems required a continued concertation between the two communities. Supplementary forage cultivation was taken up in association with cereals in the home territory of the livestock breeders. The adjoining plots, used by farmers, were traditionally reserved by the community for agricultural activities in the rainy season, and for range pasturing in the dry season. These plots were divided into pasture lands and clearly defined conservation areas, which helped meet the increased requirements of livestock herds during the dry season, while preserving crop residues for soil cover.

(Based on Naudin *et al.*, 2010).

Perspectives for land use planning using cropping systems

There is considerable flexibility in the design of innovative cropping systems for the purposes of territorial planning. We suggest some possibilities.

Landscape planning

The mechanization of production systems is leading to the gradual disappearance of trees from agricultural landscapes. The renewed interest in ecosystem services provided by various shrub species, as well as the role trees can play in mitigating the effects of climate change, are proving to be major factors in their return. Co-designing specific agroforestry systems to address this need holds great promise and can ultimately lead to the sustainable re-integration of trees into cultivated plots, and thus to a new form of territorial planning. Examples include the *Faidherbia albida* parklands, shaping the village landscape in sub-Saharan Africa, and agroforestry in agricultural systems in Vietnam.

Integration of agriculture and livestock husbandry within the territory

Although the intensification of cropping and livestock systems has often been thought out in a completely compartmentalized manner, a co-designing approach to cropping systems may open up new perspectives of integration, such as the introduction of associated forage plants or of feed-grade plots on degraded lands, coupled with innovative planning of spaces and movement of livestock herds that promotes optimal dispersion of manure. Livestock penning contracts and forage management offer solutions to help integrate agriculture and livestock husbandry, and the optimization of material flows.

Watersheds and water resources management

Constraints resulting from inadequate availability of water for irrigated rice farming have very often been addressed by the construction of expensive water retention infrastructure with its associated maintenance costs. A new approach to the design of alternative cropping systems for irrigated and rainfed rice cultivation led to several proposals: intermittent irrigation rice systems (alternate wetting and drying), minimally irrigated intensive rice irrigation systems, and conservation agricultural systems adapted to inadequately irrigated rice fields. These approaches could eventually generate new practices for water management and irrigated perimeters, and result in new watershed planning methods (Husson *et al.*, 2015).

Optimization in the use of landscape units

Despite the low productivity of agricultural production systems in developing countries, large tracts of land remain poorly utilized or under-used. Examples include the *tanety* or slopes of degraded hills in Madagascar, the *harde* (sterile halomorphic and sodic soils of North Cameroon) and hydromorphic vertisols (dedicated to the off-season cultivation of photoperiodic sorghum in the Lake Chad area). An approach of co-designing innovative and adapted cropping systems can lead to different uses of these soils. For example, bringing the *tanety* and *harde* under cultivation, by applying agroecological techniques based on a combination of more hardy cover crops with adapted root systems, can divert the pressure from livestock herds to such landscape units.

Multifunctionality of rural areas

In the case of Laos, the development and dissemination of these systems has been supported by several successive projects financed by the French Development Agency (AFD): Xayabouri, Pronae, PCADR, Eficas Project, etc. This approach was complemented by taking into account different units of village terroirs, permitting, for example, the cultivation of a cash crop in addition to a rice crop for self-consumption or to a livestock husbandry activity. This functional diversity is part of the villagers' strategy to derive value from spaces available to them.

Thus, the agricultural territory fulfils functions other than its initial function of production. This is especially true when environmental services are integrated, especially those pertaining to the management of water resources, as in case of erosion control upstream of reservoirs.

Finally, the dissemination of co-designed systems also requires that farmers be supported during the transition. The introduction of such a type of innovation represents a real risk that they are often incapable of managing on their own. In Cambodia, for example, there are plans to initiate projects on large territorial units based on the establishment of irrigated perimeters.

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Chapter 12

Modelling the impact of modes of governance on territorial dynamics: the case of the oil palm in Indonesia

Pierre-Marie Bosc, Julie Wohlfahrt and Cécile Bessou

The implementation[1] of the agro-industrial palm oil production model in Indonesia is closely associated with the process of internal demographic rebalancing – between overpopulated Java and the other islands of the archipelago, notably Sumatra and Kalimantan – in the form of massive transmigration programmes between 1970 and 1990. During this period, issues of territorial governance were addressed within a strictly hierarchical framework by the State, which, at the same time, controlled and regulated land allocation, migration, and investments in plantations and palm oil factories. This asymmetry in power between the State and local communities had a profound and lasting effect on the distribution of land resources between various categories of actors. The gradual increase in private investments and the privatization of several public agro-industrial complexes did little to change the unequal distribution of land, dominated by industrial plantations (mostly private) and their satellites of family smallholders operating under contract. Furthermore, until the start of liberal reforms which were initiated with the decentralization process in the early 2000s, the State retained ownership of forest areas and allocated concessions, as well as the power to allocate new concessions. However, the process of decentralization seemed to offer opportunities for the first time to local actors to take part in decision making regarding territorial development.

From a conceptual point of view and with regard to the specificity of the oil palm, a territorial approach makes it possible to take into account several different dimensions:
– the establishment of a plantation constitutes an investment and it rapidly becomes a productive capital, whose strong territorial anchorage is very closely linked to agro-climatic conditions (the optimal zones for oil palm cultivation correspond to

1. This chapter is the result of work carried out under the 'Sustainable Palm Oil Production' research project funded by the French National Research Agency, known as the SPOP project (ANR-11-AGRO-0007 project), under the Agrobiosphère 2011 programme.

the equatorial regions) and whose 25-year life cycle, linked with that of farms, shapes the landscape in the long term;
– the extension of palm plantations also influences the distribution of populations (time to travel to plots) and processing activities (delays in processing palm bunches after harvesting);
– the issues of the management of natural resources and the environment justify territorial approaches since agricultural plots and farms generate externalities or amenities whose effects are not contained within their boundaries (most notably effects of pollution from fertilizers and phytosanitary products, effects on the maintenance of biodiversity and on carbon storage). The watershed concept in relation to the pollution of water courses is an apt illustration.

Until recently, decisions pertaining to these different dimensions were beyond the ambit of local authorities. And even now, in spite of the current emphasis on decentralization, the habits inherited from a period of rigid hierarchical management leave little room for new practices because of the asymmetries between agro-industries, local governments, village communities and independent producers.

The diversity of family farmers

An initial survey conducted in 2013 in Kampar and Siak districts (Riau province) revealed a wide range of oil palm production systems – with farms and plantations ranging in size from 2 ha to 110 ha – which were part of very diverse systems of revenue-generating activities (Baudoin *et al.*, 2015; Moulin *et al.*, 2016). The annual income generated by individual farms varies greatly (5,300 USD on an average, with a maximum of 69,500 USD), but is generally higher than the average Indonesian income. Nevertheless, there is room for improvement. This heterogeneity of household incomes highlights the rapid social differentiation resulting from the growth of oil palm cultivation. It can be attributed to different strategic approaches adopted by the farms, which depend on various possibilities of investment, from one or more plots managed wholly or partly by the agro-industry, optionally in association with plots established independently by the farmer. The technical performance of plots managed by the palm oil agro-industry is higher than that of independently managed plots, where the technical model has to be adapted by the farmer to his financial constraints.

An example of multi-agent modelling

Modelling was envisaged as a tool for helping varied actors work in concertation in territories where palm plantations represent significant and relatively irreversible investments. As part of the SPOP project, a multi-agent modelling tool – the Palm-Lab Model – was developed using the Cormas multi-agent modelling platform. It uses empirical data to explore different plantation scenarios. This kind of modelling incorporates the diversity of actors and their behaviour, as well as their interactions and resulting effects on the environment in a given context (Grimm *et al.*, 1999). The effects of such processes are not direct or immediate, and recourse to multi-agent modelling – even if it is based on certain unavoidable simplifications – makes it possible to visualize impacts that are difficult to identify through research methods based on observation over conventional time frames.

The Palm-Lab Model takes into account three types of oil producers: industries, villagers, and investors. They are defined by their initial capital (for example, villagers own land at the start of the simulation, whereas investors do not) and by their short-term strategies (limited to fertilization) and those over the long term (decision to set up a plantation and land transfers). Although this model does not consider the State as an explicit agent, the impact of different policies can be assessed through overall scenarios defined by a particular setting of simulation parameters (for example, the imposition of conservation areas that reflect the prohibition on cultivating oil palm in sensitive areas). The physical environment conditions (soil types, especially peat soils, important for carbon storage) have been incorporated to assess the environmental impact of scenarios simulated by the model. The space has been divided into functional units such as the village, farms belonging to villagers, industrial plantations, plantations of investors and the forest. The basic unit of area for the model is the 2-ha plot characterized by attributes such as distance to the road, soil type and vegetation cover, which can vary during the simulation (oil palm, forest, rice, rubber plantation, roads). The age of the plantations increase over the course of the simulation. Each plot is owned by an actor whose resources vary over the duration of the simulation (income, knowledge, etc.) and whose decisions may also change during the same period.

The model's parameters are set based on empirical data since little data is typically available on the different types of actors and their strategies at the territorial scale. As far as the dynamics of sustainability certification proposed by agro-industries are concerned, it was possible to compare the effects of different certification schemes by taking into account indicators that provide information on social equity (according to the types of producers involved) and environmental impacts (forest cover and plantation dynamics).

The model was used for three scenarios that are very different, especially in terms of the distribution and regulation of land use (land sparing):
– without rules or constraints;
– under regulations formulated by palm oil industries;
– with environmental awareness and protected areas guaranteed by the State.

First results

Role of the mode of governance

According to the model's simulations, there are several possible perspectives. In the absence of regulation, the entire territory will be covered with oil palm after 50 years, i.e., after two productive 25-year cycles. During the first 25 years, forest cover is greater in the 'awareness' scenario, but it decreases thereafter, and finally becomes smaller than in the 'regulation by industries' scenario. The 'awareness' scenario, which envisages protection of certain areas by the State, leads to 'illegal' practices (unauthorized plantations) which ultimately make this scenario less effective in terms of protection than the 'regulation by industries' scenario. In its present form, the model is thus able to distinguish different situations in terms of land-use distribution. These results call into question the existing modes of governance in the territory. They also

indicate that the parameterization of the model – which makes it possible to take into account the role of the State and, in particular, the distribution of responsibilities between private actors, local authorities and State authorities in terms of decisions regarding land use – may need to be improved in order to correspond better to reality.

Dynamics of land use

Land use also varies between scenarios: the spread of plantations is significantly faster in a 'no regulations' scenario; it takes just 27 years for the oil palm to cover the total soil surface. On the other hand, in an 'environmental awareness' scenario,

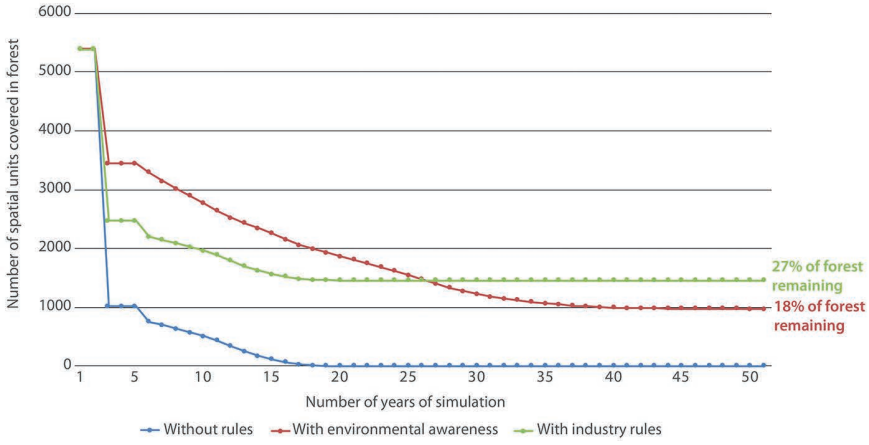

Figure 12.1. Dynamics of forest cover over a 50-year simulation cycle.

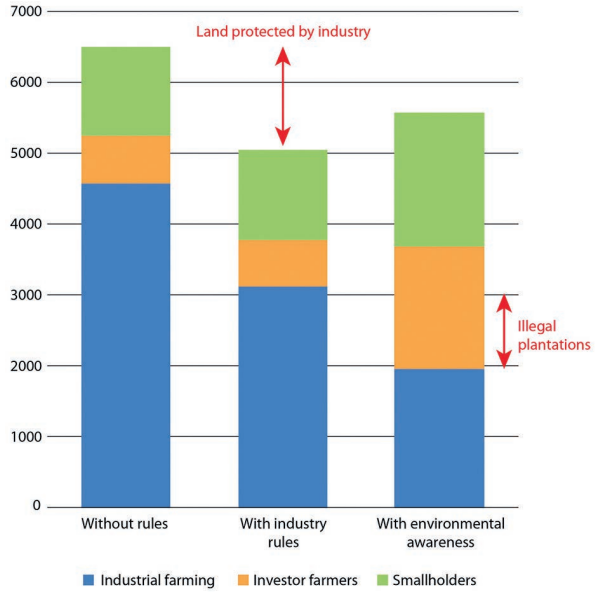

Figure 12.2 Distribution of spatial oil palm units (2 ha) amongst the different agents after a 50-year simulation cycle and for the three context scenarios.

an equilibrium is eventually reached. When considering sensitive areas, such as peat soils, the 'awareness' scenario, understandably provides more protection, with only 33% of conversion into palm plantations (as against 100%) after three years.

At the end of 50 years (with a year as time step), the distribution of planted plots varies depending on the actors but the simulation shows that it is possible to influence the distribution of cultivated plots of different categories of actors, with the 'awareness' scenario resulting in a more balanced distribution among industrialists, villagers and investors (Figure 12.1). As far as villagers are concerned, increased environmental awareness results in a significant jump in their share, from 19% to 28% of the total surface area under the oil palm (Figure 12.2).

Conclusions and perspectives

Even though the results presented here are preliminary, they show the value of an approach underpinned by an iterative process whose relevance and accuracy can be improved. This process, launched within the framework of the French National Research Agency's project, should be refined further by incorporating other empirical data and feedback from the actors themselves.

This work highlights the limitations of relying on the category of 'smallholder' commonly used in the literature but which encompasses widely heterogeneous realities. The debate which is polarized between agro-industries, on the one hand, and smallholders, on the other, would gain in clarity if the latter category were better characterized: not all 'smallholders' are 'small' holders.

The model already demonstrates that territorial regulations and controls matter, which is a significant step forward. Indeed, it seems possible for territorial governance to be freed, at least partially, from central control. Decentralization laws are opening up possibilities that territorial actors are seizing, even if this movement remains fragile. The capacity of local actors to manage territorial development is dependent on building up their skills. The model also highlights the possible role that industrial actors can play in defining these regulations. Further improvements can also be envisaged in the model to take into account the role of territorial authorities in formulating these regulations, in connection with national public policies.

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Chapter 13

Transforming the landscape of south-western Ghana: impacts and challenges of the rubber sector

Mathilde Gasperi

A bold gamble to transform the landscape with family rubber plantations

The attempt to boost the growth of rubber production through family farms was a bold gamble on the part of the Ghanaian authorities and their partners (Akwasi Owusu and Ruf, 2015). No doubt, the humid and semi-humid forest areas in the country's south-west were very favourable for the cultivation of this crop and the long-term economic prospects for natural rubber were good. However, rubber cultivation was new to local farmers and if they agreed to adopt it, it would mean that their plots would be transformed for the next 20 to 30 years, or even more. The large investment involved[1] meant that family farms would require access to sustainable bank loans that were adapted to the specific nature of the crop (seven-year maturity period).

Twenty years after having made an increase in the number of village rubber plantations a part of its strategy to diversify agriculture and fight poverty, the Ghanaian government has cause to be satisfied: nearly 10,000 family farmers in the south-western part of the country cultivate some 34,000 hectares of rubber and enjoy both an assured commercial outlet and good income conditions.

The territory as a multi-actor space structured around a sector

AFD has been supporting this unique village-based rubber cultivation in Ghana since the 1990s. Its establishment was made possible by the presence of an agro-industry in the country's south-west that processed and exported natural rubber in a *de facto*

1. Cost per hectare of about 800 euros for inputs and planting material or 1400 euros including labour and technical support.

monopoly[2] situation. Difficulties in access to land to increase its own production[3] were one of the main incentives for this company to work with family rubber plantations within the framework of a contractual mechanism supported by the State. Through this arrangement, which is still in force, the agro-industry provides inputs and technical advice to the farmers, and undertakes to purchase their entire production at a price linked to international rubber prices. In addition to adhering to the technical itineraries specified by the company, the farmers undertake to sell their entire production to the company, thus qualifying for secured credit on preferential terms from a bank for the initial investment.

The success of this scheme is due to the initiation of a dialogue and regular communication between farmers, the agro-industry and the bank. The Ghanaian government played a key role by helping create and strengthen the capacity of the association of rubber outgrowers involved in the project, and by ensuring an equitable sharing of costs, risks and benefits amongst the actors. Part of the profits is earmarked in the price formula for the rubber farmers' association. This not only contributes to the financial sustainability of the association but gives it the means required to carry out its tasks. For example, the association created its own nursery to address the farmers' initial reluctance to pay the high prices of plants charged by the agro-industry, thus ensuring a transparency in the actual cost of production of clones. Negotiations on fixing the purchase price have made the price formula more favourable for farmers (from 60% to 64% of the FOB price). The success of this project ultimately rests on a combination of factors specific to its territory: natural resources and a favourable economic context; a monopoly situation for the agro-industry, which significantly reduced the risk of 'diversion' of sales by farmers (if this risk had been too high, family farmers would not get loans from the bank); the presence of a producer organization playing its full role; and a supervisory and regulatory role assumed by the State, leading to a convergence of the interests of the various stakeholders and an equitable sharing of costs, benefits and risks associated with the project.

Impacts on the resources and people who live there

Although family farms were initially reluctant to convert part of their fields into rubber plantations, the rapid enrichment of the earliest participants in the project had a considerable imitation effect (François Ruf, unpublished). The surge in the international price of natural rubber between 2010 and 2014 has heightened this enthusiasm beyond the ambit of the project, leading to the conversion of fresh land into rubber farms by private domestic investors, mainly from affluent urban areas.

Local civil society organizations expressed concerns on the rapid conversion of fields to rubber cultivation and its likely impacts on the food security of local communities. Some instances of 'expropriations' of land of farmers by local chiefs – who are decision-makers in matters of land allocation – for rubber production were even reported. The Ghanaian authorities and the AFD subsequently initiated several studies (BIRD,

2. Absence of other cup lump rubber buyer or processor in the region.
3. The company initially had 13,000 ha of concessions, plus 5,000 ha acquired in 2014.

Kwame Nkrumah University of Science and Technology, 2015; François Ruf, unpublished) to assess such phenomena and their effects. These studies estimated that these private non-project investments involved about 4500 ha, spread over plots with an average area of 12 ha (with some even being as large as 100 hectares). At a territorial scale of about 18,000 km^2 – corresponding to the supply zone of the agro-industry[4] –, the overall area covered by rubber, about 55,000 ha, appears to be modest (less than 3% of the total area). However, this has not prevented very localized land-related tensions in regions which, in addition to being suitable for the cultivation of rubber, oil palm and cocoa, are endowed with significant resources, especially mining and forest resources, and are densely populated.

As far as food security is concerned, these studies conclude that the development of family rubber plantations has improved the local communities' access to food by increasing income for farms that participated in the project and, through ripple effects on the local economy, for others too. However, these studies reveal that the proportion of perennial crops (including oil palm, cocoa, and rubber) in agrarian systems is very high (almost 75%)[5] compared to the useful agricultural area in the country's central and western regions. Furthermore, while the first plots to be converted to rubber under the project mainly had old cocoa trees, soaring rubber prices have resulted in an increasing transformation of fallow land and secondary forests into rubber plots. Research suggests that almost half of the rubber trees are now planted at the expense of secondary forests and fallows, indirectly impacting food crops.

These studies also reveal a phenomenon of land eviction for the most deprived individuals, who are not able to pay customary chiefs the constantly increasing 'access rights' and land rents. This phenomenon refers to the broader issue of local land governance and the mechanisms and policies that public authorities and local actors can put in place to ensure a better sharing of the newly created wealth. In addition to fixing a maximum rubber cultivation area of 3 ha per beneficiary, in order to promote the widest possible access to the scheme, the AFD-funded project supports the formalization of farmers' land rights by requiring the customary authorities to provide rights of use, while specifying the duration of rights and details of the sharing of costs and benefits associated with them. This process is not simple and will be completely successful only over the long term. Nevertheless, to date, the majority of the family farmers who have taken part in the project have a 'land certificate' signed by the customary authorities.

The dynamics at work in the south-western region of Ghana make it incumbent on the country's leaders to discuss different ways to regulate land use. In addition to this problem of resource sharing, they need to curb excessive specialization and the attendant risks (price risks, health risks), and, of course, to protect the natural capital of this region (forests, biodiversity, etc.). With civil society actors and the private sector (NGOs, producer organizations, agro-industrial companies) becoming increasingly outspoken on these issues, the authorities are being pushed to react.

4. 60% of a radius of 100 km around the factory.

5. Food crops occupy an average of 14% of agricultural land and the remainder is set aside as fallow land. This data is compiled from a sample of 168 rubber producers, and the same number of farmers who do not grow latex in these two regions.

Consequently, the framework in which this regulation was conceived is undergoing a comprehensive recast. In addition to the political arguments justifying the reinstatement of the regulatory functions of the State (sharing of wealth, balance in territorial developments, and preservation of natural resources), an economic argument has now emerged from those private actors who wish to cater to a growing demand for socially and ecologically responsible agricultural products. It is in on this basis that the actors of the Ghanaian rubber industry, including processing industries and producer organizations, coming together in an inter-profession grouping, are requesting the authorities to support the dynamics of the sector by setting up a regulatory framework. As of now, local communities – to which authority for land regulation has been devolved – are little involved with this dialogue since the discussions are mainly carried out by the central authorities in conjunction with the organizations representing the sectors concerned. However, the participation of decentralized entities will be essential to provide responses adapted to the diversity of situations in the territories in the south-western region of Ghana.

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2-3 – Organizing the territory for services

Chapter 14

Geography of health: using territorial constructions to better manage human and animal health

Daouda Kassié, Aurélie Binot, Marisa Peyre, Alexis Delabouglise, Thi Thanh Pham Hoa and François Roger

In this chapter, we explore different aspects of territorial dynamics pertaining to health management by using health surveillance examples. After recalling the importance of territorial dynamics to health, we will show the importance of managing health problems through territorial mechanisms and, consequently, demonstrate how essential it is to make these mechanisms part of national policies.

Importance of territorial dynamics in the management of health conditions

The social, economic and environmental changes taking place at different scales have an effect on people's attitudes and practices, their exposure to health risks and their perception of these risks. These changes lead to new lifestyles, new livestock farming practices, and the expansion of urbanization and agricultural spaces. They modify interactions between humans, domestic animals and wildlife, and lead to an increased risk of the emergence and spread of certain pathogens (Paploray, 2002; Jori and Bonnet, 2014; Caron *et al.*, 2013; Kukielka *et al.*, 2016).

A thorough understanding of territorial dynamics can improve the management of health issues. These dynamics are complex because they involve several sectors, environmental management, epidemiology, socio-economics of agricultural sectors, evolution of land use and demography, etc. To understand them, we have to rely on the geography of health taken together with spatial epidemiology based on a biological medical model by exploring the biological, social, cultural, historical and political factors that shape the management of health risks at the territorial level (Salem *et al.*, 1992; Dummer, 2008). This method combines quantitative and qualitative approaches, and uses complementary means for investigation and action,

such as geographic information systems and remote sensing, companion modelling, participatory epidemiology and medical anthropology.

The territorial approach, on the other hand, is based on the analysis of social, institutional and biophysical interactions, and highlights the spatial expression of health conditions and the resulting practices (location of health products and services, zoning, control strategies, etc.) (Salem *et al.*, 2012).

A territorial approach to zoonoses, diseases that can be transmitted from animals to human beings, thus takes into consideration the dynamics of the habitat of wild and domestic animals, and those of occupation of land by human populations. This analysis aims to monitor an epidemic by integrating spatial scales, social groups, risk factors and risk areas. It helps in the implementation of measures to prevent, monitor and control health problems. For example, the fight against certain parasitic food-borne diseases such as opisthorchiasis[1] requires an analysis with several dimensions, including the environmental (considering transmission mechanisms from snails to fish in the water), socio-economic (at the level of the fish farming sector), and cultural (pertaining to existing practices of consumption of raw food).

Finally, systemic approaches such as 'One Health' or 'EcoHealth' are required to tackle the globalized nature of many diseases, including zoonoses (Roger *et al.*, 2016a; Lesage, 2014). Such control measures call for synergy between actors from the different domains of animal health, public health and the environment, along with a coordinated monitoring of surveillance policies at all levels. The challenge is, in particular, to set up and support surveillance networks capable of providing early warnings, and to create the means required to understand the complexity of emerging health problems. Irrespective of whether the goal is to adopt a course of action or merely to understand processes or events, intervention at the territorial level is essential.

National health policies and global frameworks cannot be independent of the territory

A population's health depends on factors that transcend the local level. The recent emergence of Ebola in some African countries has highlighted the vulnerability of populations when national health systems are found wanting. This outbreak even led to borders being sealed to prevent the spread of the disease. However, the implementation of health regulations designed at international and national levels must take into account the practices and rationales of territorial actors and their historical contexts. In the case of Ebola, the geographical and anthropological analyses of local practices that generate zoonotic risks (hunting and food practices linked to land management and the organization of the bushmeat sector) or that promote human-to-human transmission (poor sanitation, mobility of villagers, social practices associated with funeral rites) has facilitated the development of locally adapted control strategies (Roger *et al.*, 2016b). The emergence zones, linked to contact between animals and human beings and to initial human-to-human transmissions are, in fact, localized and

1. Opisthorchiasis is a food-borne trematodosis, caused by the Opisthorchis parasite, a trematode ('fluke').

limited to the main area of the outbreak. An insight into these phenomena helps in developing efficient warning systems that can, in turn, allow the rapid detection of the disease and intervention to limit its spread.

Similarly, the monitoring mechanisms set up to control specific diseases, such as foot-and-mouth disease and avian influenza, which represent major international challenges (Roger, 2012; Figuié *et al.*, 2015), can function efficiently only with the participation of a group of key social actors, e.g., local chiefs and community leaders who, as local socio-political heads, are essential intermediaries for obtaining accurate and timely health information. In Thai villages, for example, social networks of duck and fighting cock breeders pass on strategic health information directly to community leaders, sometimes short-circuiting the official surveillance system, especially in cases of highly pathogenic influenza in poultry (Paul *et al.*, 2015; Figuié *et al.*, 2013). In Vietnam, private actors (agrifood companies, food and pharmaceutical vendors) have more timely access to local health information than do public authorities, and thus play a key role in health surveillance (Delabouglise *et al.*, 2015, 2016; Pham *et al.*, 2016). The private actors are the ones who organize local risk management and information dissemination programmes in the territory. Although veterinary authorities are well represented in these social networks, their role as supervisors is limited to keeping the Ministry informed about incidents of outbreaks on livestock farms and, if necessary, to carrying out culling operations. In such a context, the action of government veterinarians is limited in terms of co-management of health information with livestock farmers. It is the informal networks mentioned above that are the *de facto* reference entities for the dissemination of health information.

The incorporation of territorial health systems in public policies

Health is an intrinsic part of the dynamics of territories and can be both the cause and the consequence of their development. Leveraging territorial constructions to better manage human and animal health requires a clear understanding of health conditions and needs, as well as the harmonization of health policies with those of territorial planning. This approach not only takes into account intra- and inter-territorial interactions, but also helps in incorporating territorial considerations in national policies, especially for the purposes of recognizing and reducing health inequalities. Beyond a solely territorial approach, a linking of public policies to spatialized as well as 'multi-location'[2] approaches (Cortes and Pesche, 2013) makes it possible to comprehensively address diverse threats to biodiversity, security, etc., as also health, which, not being bound by frontiers, has to be thought of in terms of networks and flows (Chapter 3).

The role of territorial constructions in the effectiveness of health policies is clearly reflected in national policies when it comes to changing risk behaviours. Coherence between local and national systems is therefore necessary. Indeed, even if global or

2. Approaches based on monitoring and recognition of health events and conditions in different geographical areas in order to compile and combine them, and possibly network them.

national level policies contribute to improving the behaviour and health of populations, their implementation can increase inequalities when prevention campaigns do not reach all territories, or are not well perceived or accepted by underprivileged populations. Recognition and articulation of territorial mechanisms and the taking of local realities into account help improve the formulation of national policies and, in particular, of awareness-raising campaigns.

In France, the local health diagnoses sought by territorial authorities for a better understanding of health inequalities and for adopting remedial measures are an apt illustration of this. For example, highlighting intra-urban disparities in access to breast and colorectal cancer screening in the Île-de-France region has led to lasting partnerships between academics (health geographers at the University of Paris-Ouest-Nanterre-la-Défense), associations of locally elected representatives, local authorities, cancer screening entities, the Île-de-France Regional Council and the Regional Health Agency. This knowledge transfer and co-production mechanism has led to the identification of several factors of unequal access to screening for these cancers, linked to the organization and functioning of territories (rationales of exchanges, barriers, segregation, etc.), and how different actors (residents, elected officials, institutions, etc.) appropriate and transform the territory (Vaillant *et al.*, 2012). It has thus contributed to the implementation of the French National Cancer Plan.

Furthermore, it is difficult to adopt a uniform approach to health surveillance on a national or regional scale and, here too, the adaptation of mechanisms to local specificities and the linking of territorial and national processes are essential. In the field of animal health, for example, the perception of risks associated with livestock activities differs depending on the actors, in particular for pandemic risks. We have seen that the networks of health sector actors are not necessarily in coherence with the configurations of the official national surveillance system. Livestock animals have financial, emotional, social or cultural values attached to them that determine how willing or reluctant the breeders are in implementing control measures, behaviour that is clearly evident during massive culling operations.

In conclusion, incorporating human and animal health mechanisms into the territory can help institute a governance of health risks in line with the interests of actors and policies adapted to a variety of contexts. To this end, the organization of health services and disease control efforts becomes more relevant when it is part of a systematic framework similar to One Health and which takes into account different aspects (environmental, agricultural, health, rural development, etc.) of territorial complexity.

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Chapter 15

Agroecological pest control and landscape organization in the French West Indies

Philippe Tixier, Dominique Carval, Christian Chabrier, Luc de Lapeyre de Bellaire, Marc Dorel, Claire Guillermet and Jean-Michel Risède

Integrated pest and disease control, in particular through bioregulation processes, is the basis for direct services to reduce pesticide use for the benefit of farmers and society. Its effectiveness is the result of the integration of these processes through practices whose application ranges from the level of the individual plant to that of the territory, in the broadest sense. This requires complex forms of collaboration between farmers, the various actors of the sectors concerned, and those involved in the territory's management. Banana plantations in the French West Indies are the target of a number of air- and soil-borne pests which exhibit highly contrasted dispersal traits. Since the late 1990s, producers, driven by societal demand, have made fundamental changes to their technical itineraries to reduce pesticide use. New practices have been adopted in the island territories of Guadeloupe and Martinique as a result of improved knowledge of epidemiological and bioregulatory processes, and an integrated organization of the sector and of territorial management. The control of pests that affect bananas is characterized by farming practices that are often applied in plots, but whose effectiveness depends on their generalization at the farm or landscape level. We illustrate here how this integration of levels has enabled the optimized control of the banana weevil *Cosmopolites sordidus*, of plant parasitic nematodes, in particular *Radopholus similis*, and black sigatoka *Mycosphaerella fijiensis*.

Control of the banana weevil

The control of the banana weevil *Cosmopolites sordidus* is an archetype that highlights the fact that pest control can be truly effective only through a thorough understanding of the epidemiological mechanisms involved, followed by an implementation of pest

management practices on a large scale. This pest, whose larva burrows tunnels into banana corms, causing them to fall or limiting the plant's ability to take up nutrient and water, has a relatively low mobility and fertility. Since the 1990s, pitfall traps have been used with an aggregation pheromone attractant (Rhino *et al.*, 2010). One such attractant, Sordidin (Budenberg *et al.*, 1993), lures individuals of both sexes within a radius of about ten meters. Radio-tracking of the movement of individual insects (Vinatier *et al.*, 2010), based on range, coverage and pheromone traps, have helped identify conditions that enhance the effectiveness of these traps, and thus propose improvements. Spatially explicit individual-centred models have subsequently been used to understand how to optimize the organization of habitats and traps (Vinatier *et al.*, 2012). Simulations have shown that pheromone traps are most effective at the interface of cultivated and fallow plots. They have also demonstrated the importance of trapping at the farm level. This new knowledge has been assimilated by over 80% of the farmers, thus cutting down on the amount of insecticides used to combat this pest. These practices have also led to the creation of rural enterprises that offer pest trapping services. Furthermore, this structuring of actors has helped in disseminating optimized practices. Like many agroecological practices, the trapping of the banana weevil is effective only if it is carried out at the level of the territory, and over a sufficiently long period of time (Duyck *et al.*, 2012).

Control of plant parasitic nematodes

The control of plant parasitic nematodes in banana is a successful example of the implementation of pest control at several spatial levels and of institutional support. The plant parasitic nematode, *R. similis*, leads to root necrosis which causes banana trees to fall. From a biophysical point of view, the control strategy developed in the French West Indies was based on introducing fallowing – with a fallow or rotation period free of plants that host *R. similis* – using nematode-free planting material grown through *in vitro* culture, and by preventing or limiting any contamination of sanitized plots by appropriately channelling water flows that are likely to transport nematodes from contaminated plots. In fact, given that *R. similis* has dissemination capacities reduced to only a few metres, the risk of passive transportation via runoff requires the adoption of supra-plot approaches to prevent its spread. The strategy is based on an accurate understanding of the relationships between plants and nematodes (Quénéhervé, 2008) and between nematodes and their environment. It has required a rethinking of the organization of farms. The temporary conversion of a portion of each farm into a non-productive area has necessitated changes in the organization of farm labour, but fallow-based systems have proved to be economically and ecologically more efficient after a transition period (Blazy *et al.*, 2009), leading to a greater durability of banana plantations. Finally, management of water flows at the farm and territory levels has often been improved to minimize the contamination risk (Chabrier and Quénéhervé, 2008). The adoption of these innovations was facilitated by European aid to purchase healthy plants derived from *in vitro* culture. Applied at a territorial level, this strategy led to a 96% reduction in the use of nematicides over about 20 years.

Control of the causal agent of black sigatoka

Efforts to control the causal agent of black sigatoka *Mycosphaerella fijiensis* in banana highlight the need to work at a territorial scale. Indeed, the spores of this fungus possess a dispersal capacity of more than a kilometre in the case of ascospores (Rieux *et al.*, 2014). This disease not only drastically reduces the leaf area of bananas but also reduces the shelf life of fruits, which is unacceptable for an export crop (Castelan *et al.*, 2013). The efforts to control this disease in the French West Indies has to be seen in the light of the pathogen's recent arrival (2010 in Martinique and 2012 in Guadeloupe), and in the context of increasingly restrictive regulations: a ban on aerial fungicide applications and a limited number of approved pest control products. These dual biotic and regulatory constraints have forced farmers to rethink their control strategies at multiple levels: plant, plot, farm and territory. At the plant level, regular leaf-stripping was recommended to limit fungal growth and its effects on fruit quality, since leaf necroses are a source of spores. At the farm level, this practice required a reorganization of labour. Finally, at the territorial level, the ban on aerial spraying led to a cessation of generalized and centralized application with prior notification, as treatments became ground-based and were carried out by individual farmers. In fact, there has been observed a very strong heterogeneity in the use of fungicides in a same bioclimatic zone, which greatly increases the risk of the appearance of strains that are resistant to fungicides. Furthermore, the high dispersal capacities of ascospores can promote the spread of resistant strains from one plantation to another, irrespective of the practices of individual farmers. This threat, which could, in the very short-term, affect control strategies for this disease, is compelling farmer organizations to rethink the model of the collective management of the disease at the scale of the entire agricultural territory.

Outlook

To control the three main pests of banana in the French West Indies, it is necessary to simultaneously adopt a set of methods at several spatial and organizational levels. Societal, biotic and regulatory changes have forced significant modifications in control strategies. This triple experience shows that the control of pests requires a good knowledge of their biology (dispersion, bioregulation process) and an appropriate multi-actor organization. Given the trend of increasing biodiversity in agroecosystems (already achieved by the introduction of service plants in more than 10% of the area under banana cultivation), this diversity will involve managing the seed distribution chains as well as those of plants suitable for integration into agrosystems. In addition, services provided by diversified agrosystems, such as biodiversity conservation, will need to be evaluated. This type of strategy requires an integrated and biodiversified organization of the territory to meet the demands of civil society (reducing pollution at the source, maintaining agricultural employment, conserving or even improving landscapes) while improving farm sustainability.

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Chapter 16

Control of invasive species in island territories

Jacques Tassin

The term invasive species is used for animal or plant populations that exhibit an ability to colonize new spaces and pullulate, often hampering resource management. Thus, they tend to go over borders of any kind, moving more or less freely from one territory to another. These intrusive populations pose specific problems for the environment by altering its composition, physiognomy or functioning to varying degrees. The thresholds in the perception of their harmfulness depend on the underlying cultural references and the situation of the actors in the territory.

The problems of invasive species are particularly acute in island territories, which are vulnerable, disturbed and poor in indigenous genetic resources, and thus more favourable to introduced species. The important control programmes launched in these territories often fail to garner consensus within local structures, pitting people who value exotic species, for agriculture or forestry, against those who perceive them negatively because they expand into natural environments to the detriment of native species or ecosystems functioning. It is only by comparing and reconciling different points of view at the territorial level, within working groups that bring together all stakeholders, that a consensus can be reached.

Reconciliation of interests on Réunion Island

One such approach was adopted on Réunion Island at the end of the 1990s, as a result of meetings of the scientific advisory committee of the island's branch of the National Forestry Office (ONF), and the formation of a multi-institution group to address invasive species at the pan-island level. An initial shortcoming of this body was the under-representation of users of natural spaces and the inadequate involvement of agricultural actors in the decision-making process. For this reason, the success of a biological control programme against the giant bramble (*Rubus alceifolius*) was marred by tensions with beekeepers and horticulturists, not only because they felt excluded from decision-making, but also because of the intrusive nature of

the programme, whose effects extended beyond plot and farm boundaries. The sawfly *Cibdela janthina*, used as a control agent, was accused of being a competitor to bees and having a negative impact on litchi and Brazilian peppertree (*Schinus terebenthifolius*) production as well.

There have, however, been several attempts to promote an island-level approach. Invasive plants were categorized based on their environmental impact, their propensity to spread, and the feasibility of control measures (Tassin *et al.*, 2006a). Similarly, the ecological consequences of the invasions were assessed (Tassin *et al.*, 2006b) and the control operations carried out in all natural areas were recorded. A complementary regional approach was proposed to take advantage of the advances made in other island territories of the western Indian Ocean (Le Bourgeois and Soubeyran, 2012). Power tussles, however, emerged at both the territorial and the regional scale, with each party attempting to promote its own values and representations related to nature. Some species engendered strong conflicts of interest, especially those which generated an income, e.g., collection of the fruits of the Chinese guava (*Psidium cattleianum*) or the berries of the Brazilian peppertree. Scientific institutions, often considered to be neutral and with no vested interests, enjoyed a comparative advantage, and this permitted their representatives to occupy prominent places in debates and decision-making.

The territorial approach to invasive species is now included in Réunion's biodiversity strategy, as part of the national biodiversity strategy for the 2013-2020 period. It is the subject of a specific document on a strategy to control invasive species. Its aim is to propose and implement island-level actions of prevention and early detection, active control, raising awareness and governance. An operational programme was established to facilitate the strategy's implementation. Researchers were involved in both phases of deliberation and planning. However, this detailed formalization of governance and planning, orchestrated at a very upstream level, must not take precedence over concertation with all local partners and users. Their presence in the Réunion invasive species group, especially from the island's beekeepers' association and the horticulturists' and nursery growers' associations, provides a necessary counter-weight to conservationist institutions. It makes it possible to balance the exclusively environmentalist perspectives of the latter with economic factors on which the well-being of users depends. The research community, familiar with partners from the agricultural profession, operates informally to promote such an expansion.

A less consensual approach in New Caledonia

This dynamic of concertation at the territorial scale is also at work in New Caledonia, albeit more slowly and, seemingly, in a less interactive way, due partly to the administrative reorganization of the archipelago into provinces in 1989. New Caledonia has three provinces, of which the South Province and North Province are contiguous, though, administratively, all of them are partially disconnected from each other. Plant species were hierarchized according to their risks for the entire archipelago to identify species that had to be targeted first (Hequet *et al.*,

2009). An initial guide was then drafted for the benefit of provincial technical services. It described the major invasive plants and appropriate techniques to control them (Desmoulins *et al.*, 2012). A second manual followed, focusing more specifically on invasive species in areas used for livestock husbandry (Blanfort *et al.*, 2014). However, this approach illustrates a tendency to make any response to the problem of invasive species in New Caledonia essentially technical, as is evidenced by the establishment, in 2013, of an 'invasive species' technical committee in the Conservatory of Natural Areas in New Caledonia.

The environmental observatory in the South Province set up an invasive species group in 2004, bringing together actors from various territorial communities, the State, and the Territory of New Caledonia, as well as representatives of environmental conservation groups and scientific and technical institutes. This group immediately associated itself with a technical appraisal that was conducted in 2005 by the International Union for the Conservation of Nature (IUCN). However, local professional sectors have scope for much more involvement in discussions on the management of invasive species, given their counterparts' participation in similar processes on Réunion Island. While the programme to control *Miconia* (*Miconia calvescens*) has broad support, the same cannot be said of introduced species that are recreationally hunted, e.g., the Rusa deer (*Cervus timorensis*) or the wild pig (*Sus scrofa*). Finally, the triple identity of the archipelago, arising from its political division into three provinces in 1989, hampers attempts for consultations and discussions on this subject.

The case of *Merremia peltata* in Mayotte

The situation in Mayotte is unique for unfavourable reasons related to territorial history and administration that hamper local debates on environmental issues. An informal working group was created in 2005 on the initiative of the environment department of the Directorate for Agriculture and Forestry (DAF). This body was not very active until 2012, when the Directorate for Environment, Planning and Housing (DEAL) took over its management. This working group, now run by the Conservatoire Botanique National de Mascarin, facilitates consultations and discussions, and has proposed initial action plans for invasive species of particular concern, such as *Merremia peltata*, *Acacia mangium* or *Adenanthera pavonina*. As users and economic actors are under-represented, the composition of this group remains asymmetrical.

The situation of the indigenous liana *Merremia peltata* is particular. Although it can cause the collapse of forest stands under its weight and the mechanical stress generated on steep slopes (Tassin and Laizé, 2015), it is still considered to be implicitly harmless by the Conservatoire Botanique National de Mascarin because of its indigenous character (Tassin, 2014). A territorial consensus on the management of this liana is therefore difficult to build, which undermines the implementation of new control measures, such as the experiments previously initiated by the forest resources division to limit its spread.

Towards a comprehensive management of invasive species giving way to territorial governance mechanisms

Although the territorial approach on invasive species is useful for its aspects of dialogue and local cooperation, it cannot be an end in itself. No doubt, the consultations and coordinated monitoring carried out at all levels are justified. But this territorial approach will be futile if it is not linked with a broader plan of action pertaining to the overall management of biodiversity. It is in this direction that territorial concertation bodies are evolving with regard to invasive species, even though their progress varies greatly from one territory to another.

It is important for the territory not to merely act as a conduit for the local implementation of decisions taken upstream, at a much wider level. To be effective and meaningful, the territorial approach for managing invasive species must be protected from possible external pressures and influences. At the very least, it must not be manipulated by international organizations that, under the pretext of 'fragmentation' or 'dispersal' of control measures (Soubeyran, 2008), attempt to pass on information and action methods that are universal, decontextualized and debated in forums to which the territories themselves do not always have access. However, it is not clear whether territorial authorities can operate freely in this area, or that they will be able to do so in the next few years, if the two examples of Réunion and New Caledonia are anything to go by. The research community has a role to play in legitimizing local knowledge identified by the Convention on Biological Diversity, and in the necessity of taking it into account during the adaptation of plans determined at a more upstream level.

On the other hand, it is still necessary to be able to take advantage of external experiences of territorialized management of invasive species. Major international organizations, such as the IUCN, can play the role of able coordinators or provide effective platforms for the exchange of ideas. It is incumbent on local authorities to be vigilant on this point and ensure that the territorial management of invasive species always remains genuine, useful and, above all, territorial.

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Chapter 17

Analyzing ecosystem services to manage territories

Bruno Locatelli, Améline Vallet, Giacomo Fedele and Bruno Rapidel

Territorial management can be based on analyses of ecosystem services (Opdam, 2016), i.e., on the analysis of the benefits human beings receive from ecosystems in the form of provisioning, regulating and cultural services (Figure 17.1). Management approaches based on ecosystem services are defined here as those that recognize the diversity of the services provided by ecological processes in a territory, as well as the diversity of values ascribed to these services by different actors. These approaches thus allow, among other objectives, the comparison of different management options or the design of policy instruments. They recognize numerous instrumental and relational values that include, for example, the consumption of goods and the existence of spiritual relationships with nature (Díaz *et al.*, 2015). It should be noted that these approaches transcend economic assessments and payment mechanisms, which often form the focus, speciously so, of analyses based on ecosystem services.

Territories and ecosystem services at different scales

Decisions concerning a territory impact its ecosystems, but the services provided by these ecosystems can be supplied beyond the borders of this territory, referred to by geographers as 'disjunction of levels' and by economists as 'externality'. For example, hydrological services can reduce flooding in a distant downstream city, and carbon sequestration is an ecosystem service that regulates the global climate for the benefit of all of humanity (Opdam, 2016). For this reason, analyses of ecosystem services often take into account, in a spatially explicit way, the supply of services by ecosystems, societal demands and linkages between ecosystems and human beings (Locatelli *et al.*, 2014). This aspect is crucial for stakeholders who are interested in the implications of management decisions on ecosystem services (Fürst *et al.*, 2014). Their spatial analysis can even lead to the demarcation of new territories.

For these analyses to be useful for territorial management, it is necessary to understand how management practices influence the supply of ecosystem services. Since a service exists only as a link between an ecosystem and beneficiaries, its analysis

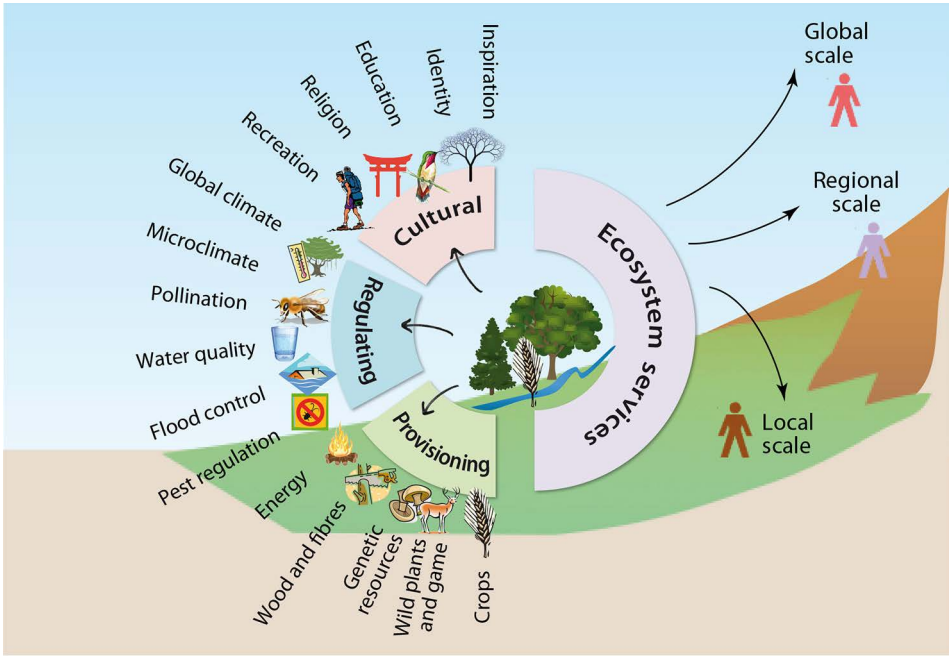

Figure 17.1. Examples of provisioning, regulating and cultural services provided by a territory to beneficiaries at different scales.

Source: authors.

requires moving from a particular management scale, such as that of the plot, where the farmer's practices reign, to the scale of the territory where these ecosystem services are provided, or to the scale – regional and/or global – where services may have an effect. This change in scale is straightforward for some services (e.g., the service of climate change mitigation provided by ecosystems at a global scale is the result of the local contributions, regardless of their location), but is more complex for others. For example, in Costa Rica, the presence of shade trees in coffee systems reduces erosion in the plot but, at the level of the watershed pertaining to this ecosystem service, erosion is dictated by threshold effects and can increase or decrease depending on processes involved at larger scales, e.g., retention or release of sediments in the basin (Villatoro-Sánchez *et al.*, 2015).

Why approach the territory through ecosystem services and ecosystem services through the territory?

An important aspect of ecosystem services approaches is that they make it possible to take into consideration various contributions of ecosystems to human well-being, for example, understanding the effects of the evolution of a territory on landscape beauty, food production, carbon sequestration or water regulation (Vallet *et al.*, 2016b). By bringing these services together, analysts and managers are able to consider the trade-offs between different options for addressing challenges such as climate change (Locatelli *et al.*, 2015). Since it is not possible to optimize all

ecosystem services at the same time, it becomes necessary to recognize trade-offs: if one service is improved at the expense of another, which uses and which actors stand to win or lose (Förster *et al.*, 2015)?

Since ecosystem services approaches seek to incorporate the diverse values that human beings attribute to their territory, they can prevent the management of multi-functional territories for a sole purpose, such as food production. For this reason, these approaches are linked to the multi-functionality of landscapes or agriculture (Caron *et al.*, 2008). If stakeholders have the opportunity to formulate their perceptions of and expectations from the territory in similar terms, it could help them and researchers understand the divergence of values and the search for a compromise concerning the multi-functionality of human activities (Fürst *et al.*, 2014).

In Indonesia, for example, the evolution of a territory reflects trade-offs between sometimes conflicting demands for services. In villages in central Java, the authorities decided to replace mixed forests with pine plantations for timber. According to farmers, rice harvests have been reduced by such plantations and droughts. To mitigate economic risks, farmers planted teak in soya bean fields (agroforestry) and reforested the slopes considered the least productive (assisted natural regeneration). In doing so, they have strengthened, at the same time, provisioning services (wood) and regulating services (soil stability and fertility) to complement agricultural provisioning services (Fedele *et al.*, 2016).

The identification of benefits human beings receive from ecosystems and, consequently, the definition of these services remain subjective, making the concept abstract. However, the concept, with its broad definition and its consideration of multiple values through multidisciplinary analyses (beyond economic or monetary values alone), can be useful for decision-making concerning territories. Ecosystem services can help stakeholders discuss territorial management at the appropriate spatial level, think long-term as well as short-term, and assimilate multidisciplinary knowledge (Fürst *et al.*, 2014).

Ecosystem services approaches can contribute to the organization of the territory by creating networks and strengthening relationships between actors, especially between those managing ecosystems (e.g., farmers) and those benefiting from these services (e.g., downstream users of water). Discussions of their benefits have not only already led to partnerships between farmers, water managers and actors involved in the protection of cultural values and biodiversity, but has also helped consensus decision-making concerning the territory (Fürst *et al.*, 2014).

The concept of ecosystem services makes it possible to think of ecosystems not as objects threatened by the territory's economic development, but as elements to be considered in the planning of this development (Opdam, 2016). It has been shown, for example, that ecosystem services approaches make it possible to think of opportunities instead of problems (Baker *et al.*, 2013). By highlighting the multiple benefits provided by ecosystems, the concept makes it possible to involve actors in the management of the ecosystems on which they depend without often recognizing it, for example hydroelectric companies with upstream forests (Locatelli *et al.*, 2011).

Challenges of ecosystem services approaches for territories

Despite their potential, these approaches have not yet been widely used in territorial management (Cowell and Lennon, 2014). Some of the reasons can be found in the diversity of scales at which ecosystem services are supplied, and the divergences between these scales and those of territorial management, and the divergences between actors. Driven by strategy or by the desire for power, actors responsible for the management of territories can decide to ignore certain services or promote others, even if the scientific analyses or the beneficiaries' perceptions suggest other priorities.

A participatory approach to ecosystem services can co-opt different visions of all the actors within a territory, but its success depends on governance systems, the socio-cultural context, and interactions between actors. Deliberations on ecosystem services and their management highlight different values, which depend on the interactions of actors with their services and their vision of the world (Fürst *et al.*, 2014). It is thus important to establish participatory activities in which all actors contribute with their own mental models of nature, for example, by using, if necessary, other terms for service if this latter could possibly be misinterpreted (Baker *et al.*, 2013).

Different perceptions of ecosystem services often reflect power relationships between actors. Recognizing the trade-offs between services leads one to question the power relationships between those who exert the most influence on the evolution of the territory and those who suffer from changes in the production of these services (Berbés-Blázquez *et al.*, 2016), e.g., between urban and rural populations in the case of watershed management. These questions of power come to the fore during decision-making concerning the territory.

For example, in a Peruvian Andes watershed, an analysis was undertaken of an actors' network linked to provisioning services (food and medicinal plants), regulating services (water, soil, climate) and cultural services (beauty of the landscape). The study highlighted that beneficiaries of ecosystem services and ecosystem managers have few opportunities to interact with each other. The beneficiaries of the services have little involvement in the management of these services (legislation, monitoring, etc.), and are also less in contact with other actors apart from the managers, placing them in a peripheral position in the actors' network. The power asymmetries observed call into question the capacities of public management institutions to legitimately represent actors linked to ecosystem services (Vallet *et al.*, 2016a).

Conclusion

Approaching the territories through ecosystem services makes it possible to identify and analyze the multiple interactions between ecosystems and societies or between actors linked to these services at various scales. The current challenges concern the application of this analysis to decision-making concerning the territories. Various methods are needed to arrive in a participatory manner at a shared understanding of ecosystem services and to foster collective territorial management. These methods

should make it possible to adapt the concept to different socio-cultural contexts, encourage their appropriation by the actors concerned, and encompass the multiple values, different knowledge and divergent visions of the world.

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Chapter 18

Livestock at the heart of 'climate-smart' landscapes in West Africa

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In a context of strong human demographic growth, climate change is a challenge for West African agriculture, which is primarily rainfed and which remains highly dependant on local natural resources. It is therefore imperative to design a 'climate-smart'[1] agriculture, one that is sufficiently productive in food, adapted to climatic variations and which releases limited amounts of greenhouse gases.

The scientific literature indicates that options for mitigating or adapting to climate change are almost always analyzed at infra levels (plot, herd) or at meso levels (farm, household) in an isolated manner, disconnected from other components of the system. This chapter uses a holistic approach to show how the concept of the 'climate-smart' landscape encourages us to reflect more on the possible synergies between the three objectives of production, mitigation and adaptation.

The context of the study

We rely on the first results from research conducted in different regions of Senegal (Figure 18.1): Ferlo, the groundnut basin, and Upper Casamance. These regions have predominantly sandy soils and include a broad range of Sahelo-Sudanian agroecological contexts. The advantage of covering such a wide rainfall gradient (annual rainfall ranging from 250 to 1200 mm) is to be able to analyze the effect of variable climatic constraints on the relationships between production, mitigation and adaptation. The study in Senegal focused on two types of landscapes: the service area of a borehole (about 700 km^2) in the pastoral zone (Ferlo) and the village terroir

1. Referring to the most commonly accepted definition, which stresses food security and sustainable development, where gains of productivity, improved resilience and emission reductions are means to achieving both objectives (Lipper *et al.*, 2014).

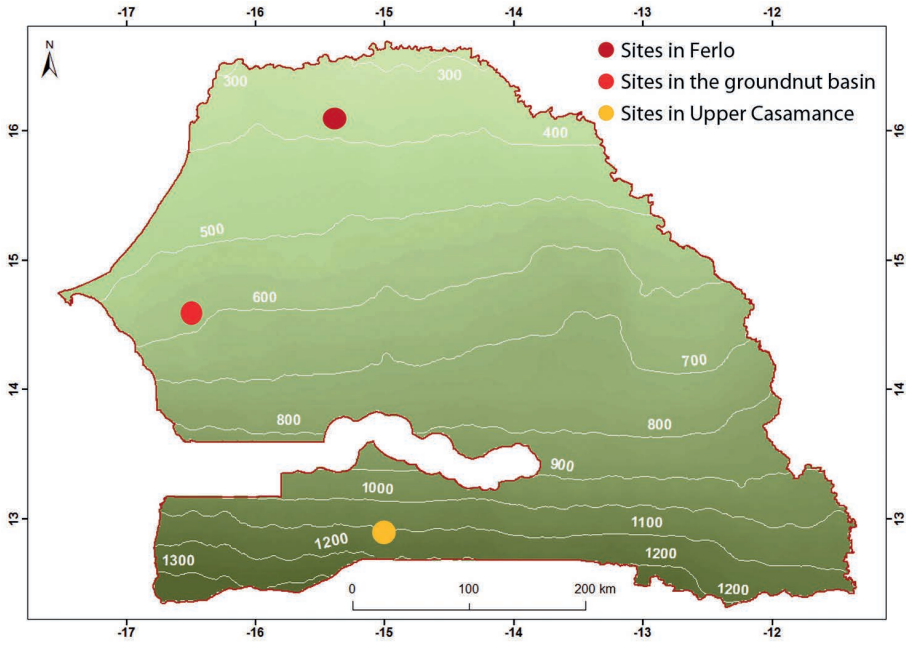

Figure 18.1. Distribution of the three study sites in Senegal across the rainfall gradient, covering a large range of climatic constraints for the analysis of their effect on the relationships between production, mitigation and adaptation.

(about 10 km^2) in the agro-pastoral zones (groundnut basin and Upper Casamance). These landscapes correspond to management units controlled by pastoral or village communities (about 360 households per borehole service area and about 120 households per village terroir).

Landscape organization, herd mobility and adaptation

In most of the landscapes studied, herd mobility is an important response to the high variability in rainfall and forage resources over time and space. Herds move on a daily basis in the borehole service area or in the village terroir (Chirat *et al.*, 2014) or, at the regional scale, over distances of several hundred kilometres (Leclerc and Sy, 2011). Local breeds have a high plasticity: they are able to adjust their daily feed intake according to the available forage types, and to store/use their accumulated body reserves – Assouma (2016) at Ferlo, Wade (2016) in the groundnut basin and Ezzano (2002) in Upper Casamance. Farmers leverage these capacities in agro-pastoral zones to maintain the herds and the required levels of organic fertilization despite high variations in forage availability. In fact, in dry seasons, animals consume plant parts that are not easily digestible (Box 18.1), leading to an increased production of faeces. Those low digestible resources are more used in drought years. Given the limited access to mineral fertilizers and, consequently, the importance of organic fertilization in maintaining soil fertility and crop yields, the role of herds in stabilizing crop production levels in agricultural landscapes is better understood.

Box 18.1. *Faidherbia albida*, a tree with multiple benefits forming the basis of a 'climate-smart' agricultural system in the Sahel.

Emmanuel Torquebiau

Faidherbia albida, or *kad* in *Sereer*, is an important leguminous tree of Sahelian agricultural landscapes, extending across the width of Africa, from Senegal to Ethiopia. Farmers find its inverted phenology very useful: it sheds its leaves in the growing season, and shades the soil with its foliage in the dry season. This characteristic helps reduce soil evaporation, while providing livestock with a shaded, cool environment during the dry season. Because of its ability to fix nitrogen from the air through root symbiosis with *Rhizobium* bacteria, the *kad* improves soil fertility. Several studies have shown that crop yields are higher in agroforestry plots that have *kad* growing in association. Finally, it is a forage tree whose foliage and, above all, pods (very high in protein and with high nutritional value) are much sought after by livestock. This exceptional versatility has made the *kad* a model agroforestry tree, frequently cited in the literature on agricultural development in dry Africa under the name of 'evergreen agriculture', mainly because of its potential for ensuring adaptation to climate change and its mitigation at the same time.

In Ferlo, due to low human population density and erratic rainfall, croplands are very limited and they do not affect herd mobility. In wetter regions, population pressure and the prominence of croplands in the landscape have a greater negative impact on herd mobility.

In the groundnut basin, past dynamics of crop extension at the expense of rangelands are increasingly hindering the presence of herds (Vayssières *et al.*, 2015): crop density is so high that less than 10% of the space is available for animal mobility (Ndiaye *et al.*, 2016). To address these constraints, some village communities have built landscapes organized around fallows (Audouin *et al.*, 2015) and networks of corridors connecting rangelands to facilitate herd movements and optimize the use of the residual space for herds (Figure 18.2).

Landscape organization, maintenance of soil fertility and food production

The borehole service area includes five types of land units: the vicinity of the borehole, natural ponds, settlements, native rangelands and forest plantations (Assouma, 2016). Similarly, the village terroir is divided into four types of land units: housing, home fields, bush fields and native rangelands.

In the pastoral zone, the daily movement of the herds within the borehole service area ensures the transfer of nutrients and carbon between land units (Assouma, 2016). Organic matter accumulates in land units where animals spend more time resting (settlements) or watering (in the vicinity of the borehole and around the ponds). Conversely, the biomass ingested by animals exceeds their excretions in grazing land units (native rangelands and forest plantations).

In the agro-pastoral zones, equivalent transfers are noted from the rangelands to the home fields (Figure 18.3), notably through the practice of night corralling (Manlay *et al.*, 2004; Saunier-Zoltobroda, 2015). This practice is meant to benefit fields close to houses that can be more easily monitored and maintained. The concentration of organic matter and labour resources on food crops contributes to household food security in a context of biomass and nutrient scarcity.

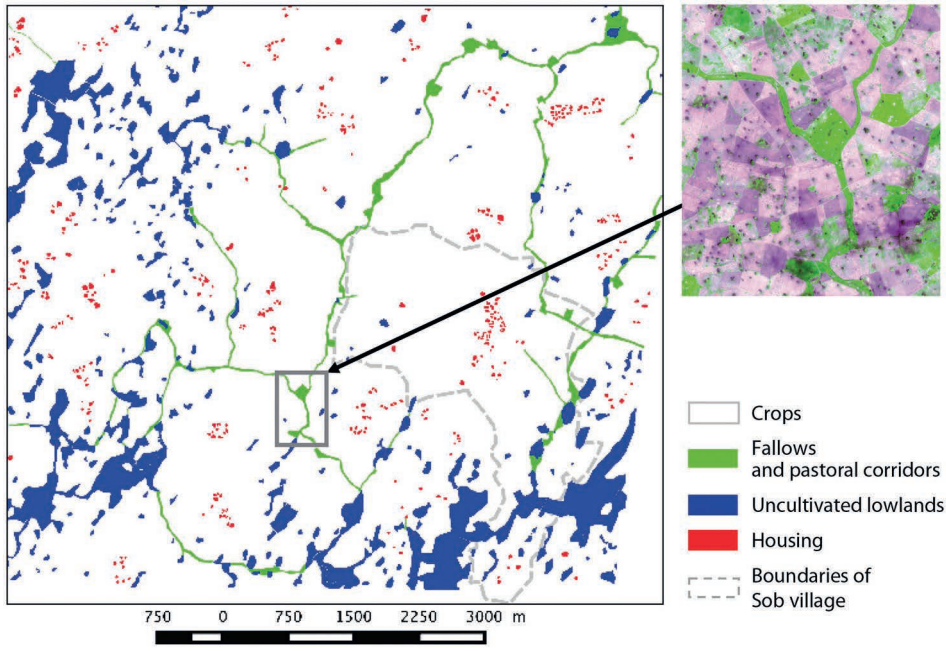

Figure 18.2. Land use map of the area in and around Sob village terroir in the groundnut basin of Senegal highlighting the existence of livestock corridors (in green) despite a landscape dominated by croplands (white) (Albrecht, pers. com.).

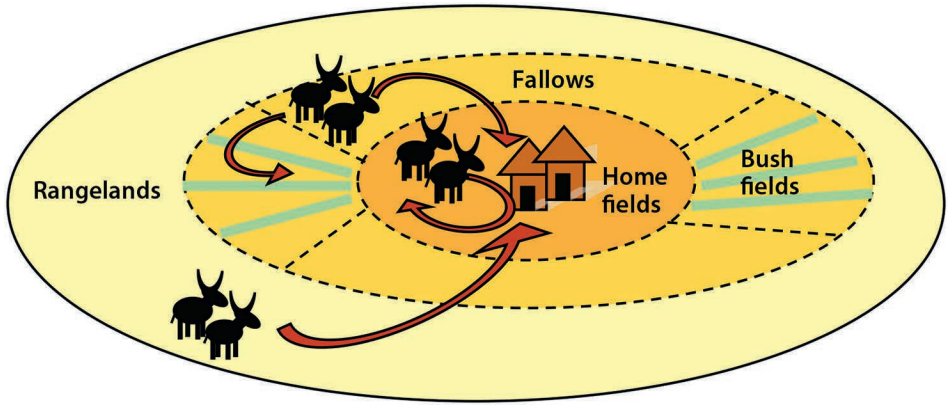

Figure 18.3. Landscape organization in concentric rings and fertility transfers by mobile herds (red arrows), accounting for 60 to 80% of the horizontal flows of nutrients and carbon within the agro-pastoral village terroir.

Landscape organization and greenhouse gas balance

An increased presence of animals and a concentration of mineral elements in some land units lead to a marked spatial heterogeneity of greenhouse gas emissions and carbon sequestration.

Land units in which animal manure gets accumulated (vicinity of the borehole, ponds and settlements for pastoral systems, housing and home fields for agro-pastoral systems) have positive greenhouse gas balances (more emissions than sequestration, in CO_2 equivalent) whereas land units from which forage biomass is removed (native rangelands and forest plantations) have negative greenhouse gas balances (Assouma, 2016).

Extensive livestock practices are at the origin of the main sources of greenhouse gas emissions in the landscape due to the consumption of low-digestible feeds (methane emissions from enteric fermentation) and the direct deposition of excreta on pastures (nitrous oxide from soil), but it prevents some emissions due to ingestion and trampling (soil incorporation) of available plant biomass, thus limiting bush fires and termite activity. The use of organic matter produced by animals to fertilize fields also curtails the use of mineral fertilizers, which are an indirect source of greenhouse gas emissions. Moreover, the presence of large livestock herds, with variable stocking rates (from 0.5 to 2 tropical livestock units per hectare depending on annual rainfall), does not inhibit carbon sequestration in the soils of pastoral or agro-pastoral landscapes. Thus, the greenhouse gas balance of the borehole service area may be slightly negative (Assouma, 2016). Greenhouse gas emissions are globally offset by carbon sequestration in trees, soil and animals. Similar results are found in agro-pastoral village terroirs when native rangelands occupy an important place (Ndao *et al.*, 2016).

Towards the design of more productive landscapes that regulate their interactions with the climate

Our work in Senegal shows that extensive livestock systems play a key role in the landscape's ability to produce food, and to adapt to and mitigate climate change. Indeed, many landscapes are built collectively to favour herd movements and crop-livestock integration. This balance between crop and livestock activities is disturbed in many parts of West Africa by the expansion of housing and croplands at the expense of rangelands (Ickowicz *et al.*, 1999; Vayssières *et al.*, 2015; Ndiaye *et al.*, 2016). This study describes landscape organizations and cropland/rangeland ratios in which the use of local resources is optimized, and in which a balance between production, adaptation and mitigation is reached. The analysis of the trade-offs between these three pillars of 'climate-smart' agriculture can be undertaken using a spatially explicit and dynamic climate modelling approach at the landscape level. It is a promising option for designing 'climate-smart' landscapes. It helps assess the role of landscape organization on the services rendered (Sané *et al.*, 2016), evaluate the effect of the past dynamics of these landscapes on the evolution of services (Grillot *et al.*, 2016) and design new 'climate-smart' landscapes with the local stakeholders, taking into account future environmental changes (Grillot *et al.*, 2015).

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Chapter 19

Urban-rural cohesion in territorial flood management

Olivier Gilard

Floods cause significant damage in all countries, especially in economic terms. Rural territories are important spaces for mitigating these impacts. We will restrict our focus in this chapter to a particular type of flooding, one caused by the overflow of a river that drains a large catchment area (bigger than a few hundred square kilometres), because significant flood damage often takes place at this scale. It is also a suitable scale for taking advantage of the complementarity and cohesion between territories.

The need for risk management at the watershed level

It is recognized that the management of flooding caused by a river overflow has to happen primarily at the watershed level and, at the very least, over the length of the valley in which the river flows. Local management, which generally relies solely on structural measures such as recalibrations and containments, has shown its limitations: the shifting of the problem to another area, one that cannot be always identified in advance; the cancellation of the effects of these measures when they are generalized from place to place; the worsening of the situation by forgetting that these measures are designed for a given expected frequency (or probability of occurrence) which can be exceeded by a particular, albeit rarer, event (Dunglas *et al.*, 2004).

Once the water enters the watershed as rainfall, and is channelled into a river, the volume of water that must be dealt with during a flood can only be moved over time and space.

The notion of risk arises from the clash of two factors in a given location. The first qualifies the probability of the flooding of a particular area. The second is the vulnerability describing the assets present there, which would suffer damage if the floodwaters reach them (Veyret and Reghezza, 2006). Vulnerability varies greatly depending on land use. Common sense states that fallow land is less vulnerable than a cultivated field, a perennial crop less than an annual crop (except for an unusually long flooding duration), a subdivision of single houses less than a town centre or industrial zone, etc. Furthermore,

it also becomes necessary to differentiate between the individual perception and the collective perception of this risk. For the farmer, whose income depends on the sale of his crops, vulnerability is linked to the loss of income in the event of the occurrence of the risk, and can be deemed to be important. For the community, loss of a crop over a limited area of territory generates a much smaller economic loss than a flood in the city centre. Risk management requires a consideration of the individual and collective dimensions at the same time. In addition, the concept of acceptable risk takes on very different meanings depending on whether it is approached at the level of the individual, the local authorities or the national community. It nevertheless remains one of the keys for reflection because the measures to be taken depend on the level of the community concerned and their funding depends on these different organizational levels.

We thus arrive at another dimension of the problem: the institutional complexity. In every country, there are a large number of institutions whose actions can have an impact on risk management: local authorities; agencies administering land; agencies in charge of land use, urban planning or related regulations; agencies handling water and water resource management; agencies responsible for civil protection, insurance and their administrations, etc.

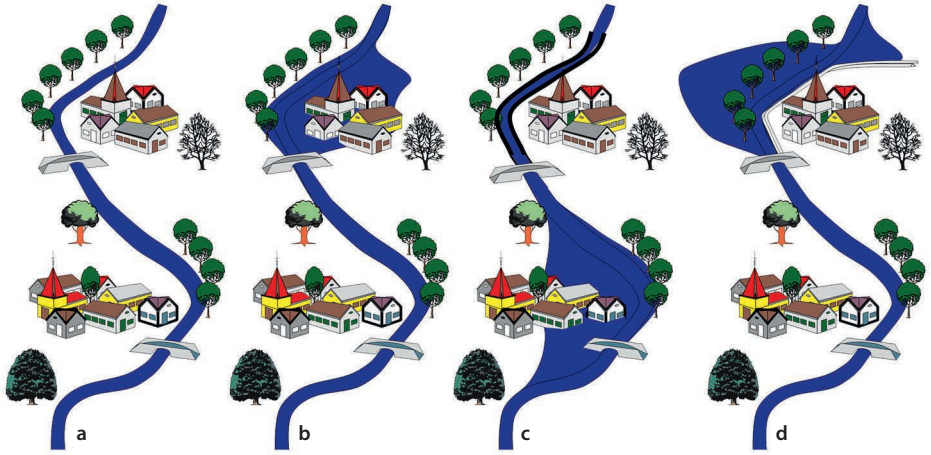

Figure 19.1 Schematic representation of river flooding before its management, with local management, and with territorial management.

Planning of river courses and their consequences:
a. Normal situation in a normal period
b. Flood situation without planning: unacceptable risk
c. Upstream recalibration and displacing flood waters downstream: unacceptable risk
d. Dyking the left bank upstream without resizing the bridge: acceptable risk.

Collective management initiatives

The need to prevent flood risks forces societies to implement collective management of a diversified space in which rural and urban areas are sequentially located. Even if this wider territory lacks a representative body, it is necessary to organize concertation between existing institutions, especially the municipalities, in order to make the

necessary choices in terms of planning for and managing risks. In accordance with the principles outlined above, we must recognize that rural areas are generally less vulnerable when compared, for similar surface areas, to urban areas. We must consequently find ways to store surplus water temporarily to reduce the flooding risk for downstream urban areas (Figure 19.1). This actually represents the creation of an easement on the plots concerned, as already exist in land laws, particularly in those of the most developed countries. To be applicable and acceptable to the rural communities concerned, such a solution needs to be supported by flood prevention and mitigation measures. In particular, it is possible to promote (possibly through *ad hoc* financing) the installation of cropping systems that are more resilient to these constraints. For example, it has been observed that mulch-based direct-seeding conservation agriculture systems suffer less damage in floods than conventional tillage systems. It is also possible to implement insurance schemes whose premiums could be paid by the beneficiaries of this approach, namely downstream urban areas which benefit from enhanced protection due to the constraints accepted by upstream rural areas. Flood warning and crisis management systems can also help alleviate some of the difficulties experienced during these events. There is a very wide scope of such support measures.

This collective management approach has been addressed in a number of studies in France (Le Bon-Nant in Savoie, La Bourbe in Isère, Le Réart in the Eastern Pyrenees, the low plains of Aude, L'Ouvèze in Vaucluse, etc.) (Gilard, 1998a). Each case is unique and the initiative may be implemented by State services (the predecessors of current departmental directorates of the territories) or by the municipalities along the river – often coming together as a joint association, or the Local Public Basin Establishment (French abbreviation: EPTB, responsible for the management of the local watercourses) –, often in reaction to a flood that caused significant damage. Although risk estimation is most often entrusted to qualified experts (consulting firms), the vulnerability can be assessed only through a participatory approach that brings together the 'rights-holders' of these rural territories through public meetings organized most often at the municipal level, thus enabling genuine local negotiation. Such an approach also underpins deliberations on the Red River Delta in Vietnam (Gilard, 2006) and on the Antananarivo plain in Madagascar (ongoing studies and project). They are also found in debates concerning the project to develop the La Bassée plain upstream of the Paris region to manage the flood risks of the Seine River[1]. A guide for taking agricultural activity and natural spaces into account in the context of flood risk management (MAAF, APCA, MEEM/DGPR, 2016) not only describes the role that agricultural areas can play, but also the compensations that can support the approach.

The example of the management of the Isère River

The Isère development project upstream of the Grenoble agglomeration was implemented by Symbhi (French abbreviation for Joint Association of the Isere River Basins) and was awarded during the Prévirisq flood meeting day on 17 October 2016

1. Special commission for public debate on the development of the Bassée plain upstream of Paris, session held on 10 January 2012 at Pont-sur-Seine on agricultural issues, EPTB Seine Grands Lacs, http://cpdp.debatpublic.fr/cpdp-crue-seinebassee/INDEX_2.HTM

(organized by the French association of public river-basin territorial agencies) (Symbhi, 2016). All the agricultural areas upstream of the Grenoble agglomeration are used to temporarily hold water to reduce the flood peak by scaling down the water flow, but only in the case of severe floods (greater than the 30-year high). Note that the use of these plots is not uniform: permanent grasslands sometimes used as pasture, annual crops, orchards, etc. Flood spillways were built on the lateral dykes of the Isère to direct the waters to agricultural areas or controlled floodplains, which are themselves designed to limit damage and allow drainage once the flood peak is past. Farm buildings and residential areas within these controlled floodplains are protected by narrow merlons. It is estimated that, even though this work is still ongoing, it has already saved a billion Euros in damages during a bicentennial flood, by preventing or limiting overflows into the agglomeration. A monitoring and warning system helps anticipate floods and their effects to the greatest extent possible. This project, initiated in 2004, is scheduled for completion in 2021.

Rebuilding a concept of the common

At the level of the river, such approaches allow the (re)construction of the concept of the 'common': the collective management of a common good, here the protection of a territory from a risk, by establishing cross-solidarity between different areas corresponding to different economic orientations. The approach makes it possible to take advantage of, and to put in place, a multi-functionality of spaces, especially rural ones, which remain productive for most of the time, but play a different role when circumstances dictate. In the 1990s, Irstea (formerly Cemagref) developed a method called 'floodability' (Gilard, 1998a, 1998b) allowing the operational implementation of this approach. It is based on a systematic and independent analysis of the risk and vulnerability, and proposes a suitable modelling of these two elements, as well as an innovative means of addressing them to characterize the risk situation. It offers the entities involved an objective cartographic platform for discussion and negotiation of the acceptable risk, by comparing various planning and change scenarios of both the spatial distribution of the risk and the vulnerability.

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2-4 – Mobilizing the territory as a resource

Chapter 20

Converging views on multi-sited territories in the southern Altiplano in Bolivia and southern Mozambique

Sara Mercandalli and Geneviève Cortès

In the context of globalization in its renewed form since the late 1980s, rural societies in the countries of the Global South are undergoing a dual process: on the one hand, an increased diversification of family activities (Reardon, 1997; Barrett *et al.*, 2001) and, on the other, the complexification and intensification of their mobility and of urban-rural relationships, without rupturing of links with their places of origin (Ma Mung *et al.*, 1998; Tacoli, 2002; Cortès and Faret 2009). Migration trajectories are becoming increasingly complex and integration networks are diversifying their modalities of support.

Concept of the 'multi-sited territory' in the context of the southern Altiplano in Bolivia and southern Mozambique

Echoing these processes, the concept of the multi-sited territory (Cortès and Pesche, 2013) makes it possible to take certain modern forms of territoriality into account (Giraut, 2013). It is a matter of perceiving the territory – in its role as a space that is simultaneously lived in, functional and organizational – not as a 'uni-located, contiguous and delimited space' but as 'a space that is multi-located, discontinuous, dispersed and mobilizes interactions between places' corresponding to 'archipelagic and reticular logics' (*Ibid.*, 289). The migration of rural populations, coupled with the dispersal of the family group over several residential and working spaces (Fréguin-Gresh *et al.*, 2015), is a particularly relevant key to understanding multi-sited territories and their scope in terms of territorial development. In fact, dispersal mechanisms are called into question with regard to overcoming the network-territory duality (Painter, 2009), i.e., the logic underpinning the 'networking' of family members (nuclear and extended) which creates a space for social and economic interactions at the regional, national and international levels. On the one hand, we hypothesize that the social and

spatial link maintained between the places of mobility and sedentarity prevent family breakups and fragmentation, the multi-localized space thus continuing to 'form' the territory, and, on the other hand, that the flows and circulations (of individuals, goods, money) that organize the multi-sited territory are 'resources' from the point of view of family livelihoods (Mercandalli, 2015) and of the development of rural territories.

On the basis of surveys that allowed the reconstruction of familial, occupational and residential trajectories of rural families of the southern Altiplano in Bolivia (Vassas Toral, 2015; Cortès and Vassas Toral, 2017) and of southern Mozambique (Mercandalli, 2015), this chapter examines the scope of migratory practices and of the multi-localization of families that are at the heart of the construction of multi-sited territories. We try to show how, based on differentiated modalities and conditions in these two regions, the circulations that shape multi-sited territories allow the accumulation of assets (material or non-material) within families, thus constituting a resource for territorial development. The two regions under study have in common the fact that they have been driven for a long time now by migratory phenomena. However, each is subject to very distinct processes of change linked to specific regional and international contexts. On the Bolivian Altiplano, migrations are reconfiguring in the context of the rapid integration of export-oriented quinoa producers into the world market (Winkel *et al.*, 2016). In southern Mozambique, migrations are reconfiguring as an integral part of the historical links between this region's economy and neighbouring South Africa (First *et al.*, 1998). It is thus this diversity of multi-sited territories, with regard to their relationship to territorial development, which appears interesting to study.

From the diversity of multi-sited territories and their links to territorial development

A first point of convergence that structures multi-sited territories of the two case studies are the migratory practices adopted by populations over a long period of time, partly due to harsh agroecological conditions and their distant location from economic centres of development.

The southern Altiplano in Bolivia, arid and cold highlands on the periphery of the axis formed by La Paz, Cochabamba and Santa Cruz, offers few local opportunities. Long-distance trading networks and the cultural and familial ties maintained by the populations have always linked this region to a wider space of circulation . Since the colonial period, the livelihoods of rural families have combined agriculture, barter, seasonal work in the country's mines and other associated activities, such as transporting minerals to Chile. These initial forms of mobility and pluriactivity, which were generally aimed at supplementing the food supply, gave way to mobility for work to generate income for acquiring goods. The 1970s witnessed an increasing number of people migrating for longer durations to the country's urban centres (Oruro, La Paz, Cochabamba, etc.), a phenomenon that developed in parallel to the mobility for work, which often took place in local areas. In the 1980s, the attraction of urban centres and the lowlands was complemented by a strong dynamic of international migration, especially to Chile and Argentina.

In southern Mozambique, a semi-arid region of extensive farming and livestock rearing, the importance of migratory practices of rural families, beyond the existing pre-colonial mobility, is fundamentally linked to the colonial political economy with neighbouring South Africa. From 1895 until the country's independence in 1975, the region was subject to labour export agreements between this Portuguese colony and South Africa, serving as a labour reserve for the latter's mining sector. This system, which affected up to one-third of the male labour force for 80 years, established the major migration routes of families to the South African mining regions that endured in post-independent Mozambique, in conjunction with the rise of internal migration to major Mozambican cities (Maputo, Beira, Inhambane, etc.), linked to the end of the civil war (1992) and the development of the informal economy in sectors like sales, construction, transportation and public administration.

Linked to the first point, a second element structuring multi-sited territories concerns the mechanisms of multi-localization and pluriactivity of families, which can be gauged through the analysis of migratory trajectories. The reconstruction of individual trajectories provides clear examples of the intensity of the mobility and of its reticular territorial configurations. Numerous Bolivian families affirm that their members have migrated on 20 to 30 occasions (internal and international) during their life cycles to more than a dozen different places. Their trajectories indicate a very high level of pluriactivity for both women and men (agriculture, employment in the construction sector, mining and mechanics, domestic servants, agricultural employment). Similarly, in Mozambique, family trajectories over the past ten years show up to five mobility events in three or four different national and international cities, linked to different types of employment (salaried, self-employed) in one or more sectors (mining, construction, services such as small-scale food trade, building, etc.). In both regions, some individuals combine different activities during a single migration period.

However, although dispersion and spatial discontinuity are aspects of multi-sited territories, they are not sufficient attributes.

A third point of convergence is that multi-sited territories are spaces that are structured, organized and constructed on the basis of a relational system that binds dispersed and distant places socially and economically.

In both the regions studied, the territorialization of families is built on their capacity to capitalize on several places potentially conducive to mobility and to harness spaces of collective migration and link them to the community space and the local productive system. Indeed, the territorial anchorages of these populations have multiplied, as they are widely spread out between the rural area and city of migration. The multi-sited territory is born from such a configuration and the relationships of this dispersion to the systems of activities. Because, while local anchoring (and the link to agricultural activity) is the first step in the territoriality of rural families, their mobility builds another level of their territoriality, this time linked to reticular mechanisms that link places with complementary resources, themselves a part of regional dynamics and globalization. It is indeed this multi-sited nature of family territorialities, resulting

from a permanent dialectic between here and there, which produces a multi-polar territory collectively shared at the family and the community levels.

Networks and social organization of households

Two elements underpin the mobility of families and the spatial footprint of multi-sited territories: on the one hand, the networks through which migrants obtain access to different assets in their places of insertion (employment, housing, skills, etc.) and, on the other hand, the social organization of households (families that are monogamous, polygamous, within or outside the lineage, etc.). Places of multi-localization constitute a system and a resource, because they support linkages and circulations – material or non-material – between family members, and thus provide a basis for their social reproduction and day-to-day strategies.

On the southern Altiplano in Bolivia, there are certain forms of mutual assistance which involve migrant members, residing outside the community, and working in the fields during labour-demand peaks in the cropping calendar. Another example of this form of linkage is the return of long-term migrants to live in their communities, and reclaiming their land for cultivation. While this situation has led to a re-ruralization of the region, it is yet to contribute to stabilizing the populations on the Altiplano. Returning migrants, far from re-settling in their original communities, often move between several places of residence. Finally, there are arrangements where non-resident migrants, who live in cities in Bolivia or Chile, lease their lands to permanent residents for cultivation. Profits from the harvest are shared, according to different forms of contractual arrangements, between the farming family and the urban landowner.

In southern Mozambique too, there exist a number of inter- and intra-family arrangements between migrants and non-migrants, thus creating social and economic links between the different places used by families. These arrangements include both the functions of consumption and of investment with regard to assets, both in the agricultural sphere (land, subsistence system, food security) and in non-agricultural spheres (human capital, non-agricultural equipment, etc.). These arrangements are part of the practices of circulation via various exchange flows, both material and non-material, and can facilitate asset accumulation processes.

The 'resource' territory and market dynamics

Despite their commonalities, multi-sited territories and the mobility of families on the southern Altiplano in Bolivia and in southern Mozambique do not constitute resources in the same way, nor to the same degree, for the families and for the local space. These differences are essentially attributable to the history of migration and to local, regional and international contexts.

The dynamics observed on the southern Altiplano in Bolivia reveal a process of inclusion of family farming in the globalized agricultural market, in connection with the international quinoa boom of the 1990s. Thus, equipped with a productive

and socio-organizational knowledge, and benefiting from an absolute advantage in the market, the high plateaus on the margins of the Andes have firmly embraced agricultural globalization. Rural families in this region have seized the opportunity offered by a global movement around food quality that offers new prospects for income generation and capital accumulation. No doubt, the expansion of cultivation of export-oriented quinoa is tending to create social and ecological tensions locally (competition for land, decline of pastoralism, unequal success of families, etc.). However, multi-sited territories and multi-localization are resources for the majority of families because of their relationship with the reproduction of the quinoa farming system, enabling them to capitalize on this comparative advantage linked to the specialization of the local economy. The viability of the quinoa-based production system depends on mobility, dispersion and the ability of families to organize themselves despite the distances involved. Multi-localization is considered a resource not only because it provides different sources of revenue that can be distributed amongst households (contributing to the development of the local space), but also because it constitutes a cumulative spatial capital of the experience of individuals, a capital that is emphatically drawn upon today to help fulfil requirements of the social organization of labour on quinoa plots. Thus, looking beyond the variation in the forms of individual anchoring, the family and inter-family spheres constitute the organizing structures of agricultural production systems.

The rural areas of southern Mozambique, for their part, are characterized by a dual context of limited integration to the market (due to the paucity of alternatives offered by the local space) and the historical dependence of production systems on the South African mining economy. During colonization and apartheid, this dependency relationship was embodied by the typical figure of the Mozambican peasant-miner, residing and working in the mines in South Africa for half of his working life to reproduce the family farming system in Mozambique. This articulation with the South African economy continued in the post-war and post-apartheid period after 1994, and was characterized by the liberalization and deterioration of working conditions. Today, with the networks having expanded the modalities of spatial and sectoral integration of the mobility of rural families, multi-sited territories remain the basis of the socio-economic reproduction of families, even as they have activated processes of differentiation within rural society. Indeed, depending on the nature of the family arrangements, and due to the different assets and resources it circulates, multi-localization constitutes a resource for a few families for productive accumulation. This is primarily reflected in local non-agricultural diversification strategies (self-employment in construction, transport, mechanics, trade, etc.) and sometimes in agricultural diversification and land accumulation. However, for the majority, multi-localization allows a simple reproduction of systems of activities and of non-productive investments.

Thus, in southern Mozambique, the effects of multi-sited territories and the mobility of families are more important for the reproduction and the maintenance of rural societies and territories than the creation of wealth for their development. Nevertheless, they play a modest but crucial role as catalysts of income and skills, which has a multiplier effects for the local economy, contributing to a diversification that is

mainly non-agricultural. Furthermore, these multi-sited territories have the potential to activate specific as-yet unidentified resources of these territories and synergies between places.

How are mobility and reticularity taken into account in public policies?

What is the scope of multi-sited territories? At the political level in particular, how to integrate the social and spatial configurations of these territories into fields of public action? It is clear that the reality of multi-sited territories not only calls into question the categories of analysis and intervention of territorial development policies in the two regions, but also, on a wider scale, in other territorial contexts.

In Bolivia, the State's vision of the development of the Altiplano territories is based on the sectoral policy of the quinoa value-chain. This highlights a disjunction between, on the one hand, the orientations of rural development policies centred on quinoa (specialization of production in the territory and anchoring of populations) and, on the other, the reality of spatial practices and territorialities of populations, because not only does the success of quinoa not necessarily induce the anchoring of a population in an area, but mobility is a prerequisite for the viability of productive systems and the social organization of labour (appeal to migrants, multiple residences and migratory circulation of quinoa farmers).

The Mozambican government's goal is to manage inclusive economic growth and reduce rural poverty. To this end, agriculture is positioned as a priority sector in two ways: first, the production of basic agricultural commodities for consumption by the population – the family sector is attributed a central role here; and second, the creation of employment through commercial export-oriented agriculture, with the help of investors. Beyond the questionable dualistic view of the rural economy, this policy ignores the importance of employment and self-employment for local families, both locally and externally, via multi-localization, a flexible model for the usage of space which populations have always taken recourse to as part of their strategies. The policy does not therefore take advantage of the dynamics and the potential of production and accumulation to use them for rural and territorial development (Mercandalli and Anseeuw, 2014; Mercandalli, 2014).

We thus see how difficult it is for public action to conceive multi-sited territorialities organized around mobility and reticularity. This conception requires the recognition that pluriactivity and informal employment, as well as the increase in urban-rural linkages resulting from multi-sited territories, modify the structures and functioning of rural territories because of the interactions they allow between local economies and the national and regional labour markets. In particular, this approach calls for consistency in the formulation of strategic plans for poverty alleviation and of employment policies, as well as of the various national sectoral strategies that are often formulated independently from one another. Finally, it calls for a governance of migration that reconciles the interests, needs and rights of migrants, as well as of the countries of origin and of destination. The wide gamut of forms of family farming, partly based on

pluriactivity and multi-localization, underlines the importance of continued reflection on the scope of mobility and multi-sited territories in the field of territorial development policies.

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Chapter 21

Localized agrifood systems

Claire Cerdan, François Boucher, Denis Sautier and Stéphane Fournier

Using dynamics between the farm and the plate to rethink an economic and social model in crisis

The globalization of markets and the increasing mobility of populations have led in recent years to marked disconnects between the economic actor and his territory, and between the food consumer and his territory. As agricultural and food products become more and more standardized, the distances between their places of production and consumption are increasing. At the same time, efforts are being made to create new relationships between consumers and producers within the same territory, or to provide anchoring for new forms of agricultural production. The specialized literature on the spatial analysis of agrifood systems explores these alternatives and the modalities of supporting them. The concept of the localized agrifood system (LAS) forms part of this perspective, and is based on several empirical studies carried out in Latin America, Europe and Africa (Muchnik and de Sainte-Marie, 2010; Boucher, 2012; Fournier, 2002). This chapter reviews the interactions between territorial processes and food dynamics, exploring the extent to which they influence the evolution of rural societies, the distribution of added value between different actors in the value chains, and the deriving of value from local resources and food crops.

A research goal and approach centred on activating territorial resources

The concept of the localized agrifood system originates from the coming together of efforts to leverage family farming products and the research conducted by economists and geographers on forms of local cooperation: districts, clusters, and local production systems. Localized agrifood systems have thus been defined as 'concrete organizations of actors providing agrifood products and services (agricultural production units, agrifood enterprises, traders, service providers, restaurant services, etc.) associated with a specific territory by virtue of their characteristics and modes of functioning' (Moity-Maïzi *et al.*, 2001).

Studies on localized agrifood systems characterize the forms of agrifood territorial organization by focusing on rural areas, where family farms and small-scale artisanal businesses engage in strategies to differentiate or qualify traditional products. They reveal very varied configurations 'according to their historical background, from very old systems to those created relatively recently; based on their ties to the market, from export-oriented ones to ones that target local markets; based on their range of activities, which could be dependent on a single activity, or on a diversified set of activities; based on their social organization, from those constituted by one or more networks of production units that are more or less analogous to those that are structured around a pivotal enterprise'(Muchnik, 2011). Their configuration can additionally depend on the forms of coordination between different actors, for example, a strict conformance to specifications of a collective label or a geographical indication (Fournier and Durand, 2015).

The originality of this approach is to recognize the way in which territorial resources are activated, whether they originate from humans, their histories and institutions; from ecosystems and landscapes; from products and associated qualification processes; or from consumers and their food habits. This approach is based on three stages: the identification of localized agrifood systems (context, actors, activities, institutions, relationship networks); the analysis of local resources and the processes of collective action (actual or potential); and the study and implementation of mechanisms to strengthen these systems (most often within the framework of a research-action project).

In Gloria, in the Northeast region of Brazil, a research project on dairy production revealed the economic and social importance of artisanal cheese dairies in the territory. The close geographical and social proximity of cheese makers to milk producers translates into a range of services specifically adapted to family milk production: higher procurement prices than from industrial dairies, weekly payments in cash, and the return of a portion of the whey for fattening the pigs of the producer. The actions resulting from this diagnosis propose innovations and adaptations to bring these units up to standards, in order to guarantee the health quality of these traditional products while preserve their organoleptic characteristics. A little further north, in Peru, the emergence of new coordination schemes that institutionalize existing networks have led to the activation of local resources. Codelac (Coordinadora de los derivados lácteos de Cajamarca), created in 2002, is a vertical coordination structure that brings together milk producers, cheese makers, traders, NGOs, public institutions and service providers. Other projects result, for example, in the establishment of a collective label or a geographical indication, market instruments that allow the institutionalization of the links between local resources, know-how and a territory.

To understand and support processes of territorialization of food systems

Research on LAS has enriched reflections on territorial economics and development, primarily through three contributions.

The first is the study of the link between processes of territorialization of food systems and of dynamics of local innovation. The latter are often based on networks of professionals, family networks and the joint action of several support institutions

(Moity-Maïzi *et al.*, 2001; Gumuchian and Pecqueur, 2007). For example, to deal with a crisis of an overproduction of milk in north-eastern Brazil, milk producers decided to offer a new product, pre-cooked cheese, for local and regional markets. This process helped respond to an economic crisis and to keep cheese production local. Geographical indications are another form of organizational innovation that contribute to the anchoring of production in a territory. The recognition of Penja pepper and Oku honey in Cameroon and Kintamani coffee in Bali as geographical indications are also initiatives that have contributed to territorial development (Fournier and Durand, 2015).

A second contribution concerns the notion of territorial resources (Gumuchian and Pecqueur, 2007). Territories result from the construction or creation of territorial resources that are activated and revealed. These resources can be tangible or intangible: soil, climate, product, landscape, or know-how, socio-technical networks, relationships of trust, a shared culture, a food culture. All of them can be revealed by a collective process of activation, involving the identification and definition of the resource and the rules governing its use. For example, it is necessary to recognize a local race, its characteristics and its potentialities, and to define the modalities of its use and promotion.

The third contribution of work on LAS pertains to the processes of specifying these territorial resources. Indeed, it is not merely enough to have a resource in a territory for it to have an impact. The territories' actors must design strategies for the specification of their resources, such as labelled products. Work on LAS and geographical indications has described the processes of specifying territorial resources well. Since 2012, the recognition of the geographical indication for 'Vales da Uva Goethe', a wine from the Urussanga region of southern Brazil, has led to the promotion of a specific offering of the territory that combines a specific high-quality product (wine produced from a hybrid variety), the promotion of Italian culture and the introduction of new tourism-related activities (regional festivals, photography competitions, ecotourism).

However, this example gives rise to other concerns. Making an excessively specific product poses the risk of excluding some of the operators, while any relaxation in the requirements and specificity of the product (to avoid these exclusionary processes) threatens the concerned territory's competitiveness in the markets. Moreover, this tendency towards specialization leads to the reduction, or even the elimination, of productive options important for maintaining territorial equilibrium. For example, the development of a localized agrifood system based on argan oil has tended to hasten the elimination of goat farms that are part of the traditional activities in the same region in Morocco (Lacombe and Casabianca, 2015).

The challenge is to move from a development model based on the activation of specific territorial resources to a model based on the specific combination of territorial resources. It is no longer a single product (a geographical indication, for example) but the total offering from the territory that guarantees the market integration of regions (Vieira and Cerdan, 2013). In Urussanga, Brazil, the Vales da Uva Goethe wine – accorded geographical indication – is but one of many other products (artisanal grape juice, ice cream, Italian gastronomy) and services (rural tourism) there.

Orienting research to better consider the intersectoral nature of agrifood dynamics

Localized agrifood systems provide an appropriate framework for action to consolidate the emergence of a new professional legitimacy of family farms and small-scale speciality food producers. They examine the relationship between local space and development more broadly, and affirm the central role of actors in the territorial development.

The field of research on localized agrifood systems is evolving. A new line of research is based on a criticism, often expressed, of the focus of certain studies on sectoral dynamics, for example, around a geographical indication. It must be admitted that research on localized agrifood systems has not always integrated wider dynamics. At a given scale, the food systems associated with these territories have, however, to be considered as a combination of chains or channels built on specific production and exchange models (agro-industrial, proximity, differentiated quality). This combination has an undeniable sectoral dimension, but also relies on territorial dynamics and co-ordination. Research on localized agrifood systems now proposes changes aimed specifically at taking advantage of the interactions between these processes of qualification and innovation and the territories in which they take place. It is thus a matter of revisiting concrete examples of innovative mechanisms for the marketing of agricultural products (a geographical indication, a territorial label) and to verify the effects of the chains and the territory on the development of the mechanism in question and, inversely, the effect of this mechanism on the chains and territories (better distribution of added value, strengthening of collective dynamics, emergence of new territorial governance). This retrospective analysis highlights the driving role of consumers, in the search for new forms of protest (against mass and conventional production), and of intermediary actors (traders, catering operators).

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Chapter 22

Urban and peri-urban recycling of organic matter, an approach based on 'territorial' ecology[1]

Jérôme Queste, Ophélie Robineau and Tom Wassenaar

By organic matter, we mean all substances produced by living beings, as opposed to matter of mineral origin. Organic materials contribute to the looping of the nutrient cycle. Some of them are consumed directly by animals. Others are decomposed, releasing simpler substances that feed soil life and plants, both cultivated and uncultivated. Their agricultural use, as fertilizers for market gardening or livestock feed, is an important aspect, especially in the countries of the Global South, because these agricultural activities are highly input-dependent. However, their use as fertilizer requires more labour than for synthetic equivalents, industrial feedstock and mineral fertilizers.

Organic materials that are recycled by humans, such as human or animal excrement, residues from the agrifood industry or green waste, have an ambiguous status. They are, at the same time, considered to be potentially hazardous waste and potentially useful resources. They are therefore known as by-products, as waste or as residues to emphasize the fact that these materials are not intentionally produced and must be made to disappear. In urban and peri-urban environments, these materials are often produced in concentrated quantity by industrial installations such as intensive livestock facilities, agro-processing plants and sewage treatment plants. Waste collection services, for both green and household waste, also contribute to the concentration of large quantities of such materials. Their high-dose discharges and their contamination by other undesirable substances, such as trace metal elements, bacteria (listeriosis) or non-degradable waste (plastics, concrete, rubble), give rise to significant health and environmental risks.

1. While being a well-established Francophone concept, mainly considered a specific form of industrial ecology, territorial ecology is not yet established internationally. Although there exists no equivalent notion, 'territorial' ecology's systemic, regional and material flow management focus is close to that of regional industrial symbiosis (e.g., Paquin and Howard-Grenville, 2009). Territorial ecology though is not necessarily action-research.

The recycling of organic matter is a historical paradox. In the mid-19th century, the increasing separation of production and consumption areas in the West during the Second Agricultural Revolution led Marx to denounce the 'metabolic' rift between man and the earth (Foster, 2000). The advent of the Green Revolution, in the second half of the 20th century, and its synthetic nitrogen fertilizers, urbanization, dietary changes, specialization of agricultural sectors and globalization exacerbated a growing dissociation, within the same territory, between the elimination of unwanted organic waste and its substitution by modern, efficient, 'clean' and odourless synthetic fertilizers. But today, agroecological principles are heralding the recycling of organic matter as a good agricultural practice.

While the principle of recycling enjoys a relatively broad-based consensus, its implementation modalities find far less agreement, especially in urban and peri-urban areas where health and olfactory issues are exacerbated. The costs of transporting and processing large quantities of materials are rarely covered by low selling prices and competition from chemical inputs. One of the paths being explored consists in substituting an exclusively commercial rationale with a territorial ecology[2] paradigm, aimed at exploiting existing material synergies between different anthropogenic activities on the same territory (CGDD, 2014).

The territory, linking geographical space to political, economic, social and cultural realities, plays a decisive role in providing human and material resources. The spatial organization of activities of production, processing and consumption of products is essential to logistical optimization. Last but not least, this approach requires coordination between very different actors, from small market gardeners to industrial-scale water treatment companies.

Two complementary case studies illustrate such an approach. They focus on the territories of two cities and their surroundings: Saint-Paul in Réunion and Bobo-Dioulasso in Burkina Faso.. In Réunion, a research and development project is the proponent of the territorial ecology paradigm. A process of dialogue, which brought together different territorial institutions, and the reclassification of recycling of organic matter as an issue of general interest encouraged the emergence – or re-emergence – of coordinated activities to recycle organic matter. In contrast, in Bobo-Dioulasso, it is not the paradigm but the practice of the actors themselves that highlights the synergies, which already exist in the territory, between creative activities and the users of organic matter: various actors organize themselves to ensure a 'manual' looping of the nutrient cycles within the territory. The density of localized social networks facilitates the stabilization, in time and space, of complex micro-arrangements between actors at different stages of the cycle. However, these informal arrangements and this 'bottom up' territorial ecology are under threat from sectoral territorial management policies.

2. Also referred to as 'industrial and territorial ecology' in France: an economic and ecological mode of development based on a systemic approach and aimed at creating, at the level of the industrial and territorial system, an organization characterized by an optimal use of resources and a high level of recycling of materials. Its operational implementation includes collective approaches to increase the efficiency of these resources by establishing connections between a territory's economic activities through the exchanges of materials.

The case of Réunion Island

Réunion is an isolated island spread over an area of 2515 km^2 in the middle of the Indian Ocean. This island territory, with very steep reliefs, is home to more than 850,000 inhabitants. It supports an industrial agriculture based on sugar exports, intensive livestock farming of chickens and pigs, and a very efficient informal market gardening sector. The disposal of organic waste has been a societal challenge and research objective for over 15 years on the island.

The island's isolation increases the potential benefits of a territorial ecology approach. On the one hand, the volumes of organic waste produced are constantly increasing, with its treatment frequently making it to the headlines of the regional press. On the other hand, the sharp increase in commodity prices in 2008 has exposed the vulnerability of agricultural households to the fluctuating prices of synthetic fertilizers.

The exploitation of this synergy between a voluminous production of organic waste that can potentially be transformed into fertilizing products and the existence of a strong and solvent demand for fertilizers is at the origin of the Girovar project (Integrated management of organic residues for agricultural use in Réunion Island). Between 2011 and 2014, this project brought together territorial institutions that are both sectoral, such as the Federation of Agricultural Cooperatives (FRCA), and territorial, like the prefecture and the community of municipalities. This project aimed to set up a multi-actor participatory mechanism to collectively explore the 'plausible promise' of a territorial chain for the industrial production of standardized fertilizers from organic waste (Wassenaar *et al.*, 2015). A major paradigm shift was to view organic matter as a renewable natural resource (Wassenaar *et al.*, 2016). The dialogue process relied on the methodology of companion modelling (Chapter 31) to undertake a participatory feasibility study based on the agronomic needs of the main crops and the requirements of the farmers of the territory. Its objective was to define the industrial processes to be implemented, estimate the quantities of materials involved and to explore the social, economic and environmental consequences of the proposed solutions for deriving value from this organic matter.

The dialogue process resulted in four scenarios for leveraging territorial resources, ranging from the absence of any change (baseline) to a production chain integrating poultry litter, pig manure, distillery vinasse and green waste to produce both low-concentration organic amendments for market gardeners and concentrated organo-mineral fertilizers for sugarcane growers.

This participatory study helped influence public policies of the territory's institutional actors (general council, community of municipalities, devolved State services). It also contributed to a widespread awareness of the potential of recycling organic waste and engendered an expectation from various territorial actors. These social phenomena helped create an inter-sectoral territorial coordination between the different sectors of activity concerned, without this coordination requiring the setting up of a new institutional actor (Queste, 2016).

However, the implementation of the recommended solutions is still hampered by several significant obstacles. The coordination between rural and urban actors suffers

from a lack of social capital, as evidenced by the forceful rejection of the use of sewage sludge in agriculture in rural areas, despite the significant economic benefits such a use would lead to, and the support of scientists it enjoys. On the other hand, Réunion is subject to twin European regulations: one on the disposal of waste to prevent environmental risks, and the other on the marketing of fertilizing products. These regulatory constraints complicate the implementation of local solutions which are strongly encouraged and heavily subsidized by the European agricultural policy.

The case of Bobo-Dioulasso city

Bobo-Dioulasso (population: 500,000), located in Houet province in south-western Burkina Faso, is often described as an agricultural city. Its surrounding region benefits from a dense hydrographic network and a south-Sudanian climate favourable for agricultural activities. The city itself has more than 150 hectares of urban market gardening and hundreds of pig, hen, ox, sheep and goat farms in the urban courtyards of residences of families in all social categories. Bobo-Dioulasso is also a regional focal point for agricultural trade: it hosts the largest livestock market in the country, as well as a wholesale market for fruits and vegetables through which passes most of the region's produce. It is also located in the heart of Burkina Faso's cotton basin and is home to a number of agro-industries (factories processing cotton fibres, oil mills, traditional and modern breweries). All of these urban and agricultural activities generate and consume organic matter. A study conducted between 2010 and 2013 highlighted the interactions between rural agricultural, agri-urban and urban activities through the circulation of agricultural products and organic matter (Robineau, 2015). Starting from urban market gardening, we describe an entire chain of interactions and highlight a real system at the level of the agri-urban territory.

More than 1000 market gardeners make a living through the production and sale of vegetables grown in open urban fields that are not suitable for construction. Market gardeners use three types of organic material, in particular: cow manure (Fulani livestock farms on the urban outskirts and urban livestock fattening farms), pig manure (especially from livestock farms in unregulated-housing areas) and urban refuse brought in by waste collectors who take a detour via the market gardens before taking the waste to the municipal dump. Market gardeners obtain such organic material through informal micro-arrangements negotiated with breeders, carts owners and waste collection associations.

Livestock farms are also connected to agro-industries. Cattle feed is complemented by cottonseed cake and residues from cotton processing. Confinement-reared pigs are fed with spent grains from the brewing industry. These urban farms participate in the recycling of the large amounts of waste generated by agro-industries. Agro-industries are themselves linked to rural agricultural production from where they get their supplies because cotton and cereals are processed in urban areas. A whole system of interdependencies exists at the territorial level as a result of the flow of organic matter. This system contributes to an increase in agri-urban activities, which generate employment for many families and are a source of animal products for city dwellers.

Public actors view market gardening activities positively since they supply fresh produce to the city and create large urban green spaces. The public authorities regard market gardens as areas to be preserved in the midst of an expanding urban space, especially the Kuinima market garden site, a 70-hectare expanse in the heart of the city, where nearly 750 market gardeners grow produce. In contrast, they do not consider urban livestock farms as activities that belong in the city. The city's current planning policy aims to shift out the municipal dump, demolish unregulated neighbourhoods – which will jeopardize livestock rearing in these areas – and build new neighbourhoods. This will make it more difficult for organic manure suppliers to access the Kuinima market gardening site, as urbanization will disrupt the traditional routes used for the transportation of organic matter, thus calling into question the long-term viability of this market gardening site.

The existing informal management of organic matter has demonstrated its effectiveness. These negotiated micro-arrangements connect actors, activities and spaces. It ensures the circulation and treatment of organic waste, which remains both a source of potential nuisance, if poorly managed, and a source of synergies, if territorial complementarities are taken advantage of. It is a way of (re)thinking the development of urban territories.

Prospects for operationalizing the looping of flows

Work carried out at these two very dissimilar locations highlights the potential benefits of a territorial organization for managing organic matter in urban and peri-urban environments. These benefits already exist in Bobo-Dioulasso and are simulated for Réunion Island. In both cases, the operational implementation of the looping of organic matter flows is based on localized micro-arrangements negotiated directly between actors. The organization of spaces, coordination over time and improved social relationships are crucial to achieving this. In Bobo-Dioulasso, this implementation is the result of direct negotiations within dense social proximity networks. In the case of Réunion, it is a top-down process initiated by the State authorities.

Our work also highlights the significant constraints that are the sectoral and spatial planning policies based on a principle of segregating urban and rural activities and on the distinction between organic matter flows of waste to be disposed of and resources to be brought in. The reconnection of the city to agriculture makes it possible to narrow Marx's 'metabolic rift' and thus operationalize one of the principles of agroecology within the territory. It requires, however, that the instruments of public action also rely on the underlying paradigm of territorial ecology.

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Chapter 23

Diversity of crops, societies and territories

Christian Leclerc, Vanesse Labeyrie and Geo Coppens d'Eeckenbrugge

For studying the interactions between crops, societies and environments the territory can be viewed as an interface between social and biological sciences. Indeed, there is a correspondence between the diversity of crops and the linguistic, social and cultural diversity of farmers, since crops are both a product and an underlying support for the identity of human groups (Leclerc and Coppens d'Eeckenbrugge, 2012). At a continental scale, this correspondence has been confirmed for the main African cereal, as the spatial configuration of language families corresponds to that of sorghum races (Harlan and Stemler 1976; Westengen *et al.*, 2014). Similarly, at the village scale, dialectal groups are characterized by their varieties (Labeyrie *et al.*, 2014).

By considering crops as social markers of territories, researchers can identify new bridges between the social and biological sciences to design strategies for conserving the diversity of local genetic resources and promoting the sustainability and resilience of agrosystems (Altieri, 1999). Using examples from Kenyan family farming, this chapter describes the processes linking crop diversity, societies and territories, and their influence on the adaptive capacity of agricultural systems.

Territories and agrobiodiversity

Labeyrie *et al.* (2014) studied the interaction between territories and crops on the eastern slope of Mount Kenya, in an inter-ethnic contact zone (Chuka, Tharaka and Mbeere) where climatic and edaphic conditions are uniform. Even at this very small scale (15 km^2), the diversity of sorghum is linked to the respective territories of the Chuka, Tharaka and Mbeere. In particular, the double-season (ratoon) varieties, with specific genetic, morphological and agronomic characteristics, are present only in the Chuka territory. The distribution of varieties also reflects the social relationships between different groups. Thus, the *Mugeta* variety, which is only present in the Chuka and Tharaka territories, testifies to their alliance relationship (*gishiaro*). Even when a same morphological and genetic type is shared by all three groups, its denomination differs. For example, a well-defined sorghum variety with gray seeds is named

'*Ngirigacha*' by the Mbeere whereas the other two groups call it '*Murugue mbura imwe*' (Kamau *et al.*, 2016). Thus, a distinct nomenclature corresponds to distinct ethnic territories, with the territories including a cognitive component.

An analysis of seed sources and flows (Labeyrie *et al.*, 2016a) shows the existence of a structured network at both levels of the seed territories. Within *ntora* (residential units), 45% of the flows are observed between women and their in-laws. The centripetal orientation of the seed trade is even more pronounced outside *ntora*, with 72% of seed flows occurring amongst relatives, a proportion that must be seen in the context of the very high rate (86%) of intra-ethnic marriage.

Territories and plant adaptation

The interaction between the territory and crops has also been studied for its functional and adaptive value. Mwongera *et al.* (2014) highlighted social processes of adaptation to climate change by comparing seed losses for eight species cultivated by the Tharaka and Mwimbi. These two groups now occupy adjacent territories at altitudes of 950 m above MSL, on the eastern slope of Mount Kenya, but each has colonized this area following migrations in opposite directions. The Tharaka had to contend with an increase in rainfall and a decrease in temperature as they migrated up the slope. The Mwimbi, on the other hand, encountered new conditions that consisted of a warming of +0.8 °C to +1.09 °C and a decrease in annual rainfall of 26.7 to 32.9 mm per 100 m of descent (Camberlin *et al.*, 2014). This variation corresponds to that observed in general in Africa over the last 40 years (McCarty *et al.*, 2001). Climatic variations on this slope can thus be studied in the same way as climate variation over time (space-time substitution design).

Seed losses were analyzed as a function of the number of days without rain during seedling emergence. According to the hypothesis of Leclerc and Coppens d'Eeckenbrugge (2012), if social barriers limit seed flows between communities, Tharaka seeds, which are already adapted to arid conditions, should be less susceptible to erratic rains than those of the Mwimbi. Indeed, by accounting for possible confounding factors (sowing practices, variety selection, number of species and varieties per farmer), the study showed that the risk of seedling loss increased by up to three times for the Mwimbi than for the Tharaka. This difference can be linked to the origins of their genetic resources, and to the fact that seed circulation is centripetal (oriented towards the centre of each ethnic group and its territory). Seeds from the Tharaka have benefited from their adaptation to droughts, which are more frequent at low altitudes. In contrast, Mwimbi seeds have traditionally been exposed to less stringent hydric conditions at high altitudes.

Thus, the history of the communities and their territory is reflected in their seeds. Since intermarriage between Tharaka and Mwimbi is rare, endogamous marriages determine the orientation of seed flows within their respective territories. The Tharaka constantly renew the adaptability of their seeds to drought in a medium-altitude territory by way of marriages with people living at lower altitudes. In contrast, the Mwimbi do not improve the adaptability of their genetic resources to drier conditions, since they obtain seeds from their in-laws living at higher altitudes.

Interconnections of territories

The examples above show how patterns of diversity, determined by marriages and the centripetal orientation of exchanges, help delimit territories. However, 'the paradox of the territory is that it includes components that are not all found within the boundaries of the space attributed to it [...] and that it is driven by a dynamic whose motive force is precisely in the tension between the boundaries and the necessity to surpass them' (Fontanille, 2014).

Thus, territories on the eastern slope of Mount Kenya do not correspond to the spatial configuration of the linguistic groups alone. Interactions with economic and ecological factors also play a role. In fact, one third of the seed lots originate from markets that draw seeds from production basins in a radius of about 10 km (Labeyrie *et al.*, 2016b). The uses specific to each ethnic group and the adaptation to different agroecological zones determine which varieties farmers buy or exchange, as a function of their cultural preferences and their farming systems. The local ratoon varieties are clearly dominant in highland areas with a semi-humid climate (950 m to 1500 m) where the Meru ethnic groups (Igembe, Tigania, Mwimbi) live, whereas the single-season varieties are distributed over the rest of the area, in the plains inhabited by the Tharaka (750 m), as well as in the more arid mountainous areas inhabited by the Chuka and Mbeere. Instead of territories with defined borders, cropping patterns suggest that the boundaries of territories can be modified from one year to the next based on climatic variations, as was demonstrated in northern Cameroon through analyses of seed networks (Violon *et al.*, 2016). In the longer term, migration processes establish and change these territories, as in the case of Mount Kenya where ratoon varieties were probably introduced from a distant area by the Meru, the first agricultural populations in the area (Labeyrie *et al.*, 2016b).

The interaction between territories and crops is thus observed at several space and time scales, and it is this characteristic that gives it its practical significance. If the diversity of crops reflects the identity of human groups linked to a territory, strategies to preserve and enhance local genetic resources must be considered at different spatial levels in relation to social, economic and ecological processes. Since the configuration of territories is in a flux, special attention must be accorded to the maintenance of seeds within residential and sociological units, as such conservation determines the adaptation of plants to local environmental and utilization conditions.

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Chapter 24

Protected areas: opportunities for socio-economic development of territories?

Karen Colin de Verdière, Aurélie Binot, Alexandre Caron, Michel de Garine-Wichatitsky and Alice Leroy

In developing countries, agriculture and animal husbandry account for significant proportion of economic output, employment and land use. In a context of population growth and its corollaries in terms of territorial impact (urbanization, increase in transport and services infrastructure), the pressure on land and natural resources continues to grow. This pressure leads to competition in the use of land to the detriment of biodiversity and is indeed one of the top five causes of the current erosion of planetary biodiversity that experts call the 'sixth extinction'.

Protected areas are defined and dedicated geographical spaces, designed to conserve remarkable biodiversity, which is relatively well preserved but is subject to various pressures (Dudley, 2008). The International Union for Conservation of Nature (IUCN) classifies protected areas according to their management objectives in six categories that correspond schematically to a gradient from the most natural areas possible (categories 1 to 3) to spaces in which there is greater human intervention (categories 4 to 6). Instead of excluding anthropized areas, IUCN recognizes that territories where human activities are regulated to serve a conservation and natural resource restoration objective are also protected areas. In 2015, IUCN listed more than 200,000 terrestrial and marine protected areas worldwide, representing 14.7% of the land area, 10% of the marine and coastal waters under national jurisdictions, and 4% of the world's oceans and seas (IUCN, 2016). The number of protected areas continues to increase, in line with the commitments of countries under the Convention on Biological Diversity (CBD). This is true even for countries of the Global South. For example, since the Durban World Parks Congress in 2003, Madagascar has doubled its protected areas in terms of surface area, with new protected areas belonging to categories 4 to 6 (areas in which human intervention is more present).

But the restrictions imposed by the creation, extension and management of these protected areas can be sources of land disputes or even territorial conflicts. Often established during colonial times, protected areas belonging to categories 1 to 3

(the most natural areas possible), especially in the developing countries, are in areas that are less productive, isolated or difficult to access. The creation of these protected areas has often resulted in the displacement of local populations or a restricted access – or none at all – to the natural resources of the areas themselves or their buffer zones. Protected areas can thus impact the living conditions of local populations by preventing traditional harvesting and use of natural products and by limiting the scope of economic activities (agriculture; livestock husbandry; firewood and timber; gathering of food products, fibres or pharmacopoeia products; fishing; hunting; etc.).

Within and around terrestrial protected areas, competition for space between wildlife and neighbouring populations can also engender conflicts. There can be direct consequences of human-wildlife conflicts, including, but not limited to, injuries and deaths caused by dangerous animals, as well as indirect consequences, resulting in losses of crops or livestock or damage to infrastructure. In Africa, these conflicts are especially widespread: crocodiles continue to attack and kill people in the Lake Nasser area of Egypt and within cities in Mozambique; leopards still kill sheep as little as 100 km from Cape Town in South Africa; and lions kill cattle in the suburbs of Nairobi (Lamarque, 2010). In these areas, human-wildlife conflicts are a particularly significant source of tensions and even of rejection by local populations of wildlife protection measures and, consequently, of protected areas.

These populations therefore perceive the protected area as a usurpation of their ancestral access rights imposed by external, national and/or international actors for long-term reasons (biodiversity conservation) that are out of sync with their short-term vital needs. In such a context, the functional incorporation of protected areas into the territorial matrix, and not as islands disconnected from their periphery, remains a major challenge.

Protected areas: a multifunctional tool for territorial development?

The primary function of protected areas is the preservation of species threatened with extinction as a result of human activities. Protected areas also contribute to the provision of ecosystem regulation services (purification of the water that passes through them or maintenance of an atmosphere without anthropogenic pollution, etc.) to the benefit of the surrounding territories. These services are essential to address the challenges of climate change mitigation and adaptation (Baguette and Locatelli, 2013) through carbon sequestration and the prevention of natural hazards (floods, droughts, etc.). Moreover, the functions of protected areas are likely to be further diversified by becoming part of territorial development trajectories. However, the perception and recognition of these functions by local communities remain limited.

A protected area is perceived locally as a potential supplier of economic resources (jobs, tourism income) or natural resources (water, bushmeat, pastureland, wood, etc.). However, access to these resources is too often limited to just those that come or filter out of the protected area. Access within the protected area to certain renewable natural resources can be permitted in more integrated management models. In Zimbabwe, for example, regulated access exists for some resources (women may enter once a week

in some protected areas to collect dead wood or thatch). Finally, protected areas can preserve sites of cultural or spiritual value (MEA, 2005).

The ambition therefore becomes to build an inclusive development project for all of the territory's actors (deconcentrated services of the State, elected officials, managers of protected areas, and local populations, including nomads or semi-nomads) so that the protected area can become an engine of local socio-economic development instead of a constraint. The challenge is to conserve the biodiversity present in the protected areas and their peripheries while building a local development project at the largest territorial scale possible, structured around sustainable activities and sectors compatible with the management plan's objectives of conservation (ecotourism, agroecology, agroforestry, agro-pastoralism, etc.).

These integrated approaches attempting to combine biodiversity conservation with development of territories on the periphery of protected areas are often jeopardized by inadequate management of land issues and rules of access between conservation areas and production areas of neighbouring populations. Areas of 'village exploitation' are usually ignored by those in charge of implementing territorial planning policies within the framework of biodiversity conservation projects. This was especially true in the planning of the Zakouma National Park in Chad (Binot, 2011). In the management plan, the areas bordering the national park have been represented as an integral part of a space divided into two concentric circles around the park, whose purpose and uses are determined exclusively on the basis of the protected area and the risk of fragmentation of the natural habitat of large fauna. But in reality, local territorial dynamics are organized around village terroirs with boundaries that shift depending on the evolution of agricultural strategies (crop cultivation and transhumant livestock husbandry), which include customary land reserves in the medium and long term and are interwoven with larger multifunctional spaces.

This inadequate management of land issues is mainly the result of a very superficial knowledge on the part of those in charge of territorial planning with regards to the complexity of the local dynamics of the exploitation of natural resources, especially in relation to the following aspects:
– the difficulty of taking into account the mobility and superimposition of rights of use on the same space that are characteristic of social, anthropological and economic systems, especially in sub-tropical Africa. The movements of 'mobile actors' generate strong seasonal demographic fluctuations locally and require territorial management to be conceived at different temporal scales (thinking with seasonal time steps) and spatial scales (including actors in the concertation framework who are physically distant but still have rights over various resources: trees, plants, water, etc.). The integration of actors such as transhumant herders in these management initiatives requires taking into account the factors that determine their choices concerning land use and pastoral practices;
– the denial of the negative land impacts induced by the zoning of protected areas and the sociological repositioning that this entails in relationships between the actors or in the modalities of exploitation of these spaces. These repositionings and their consequences (acceptance and respecting of new zoning, etc.) take time to be truly assimilated by local actors;

– the socio-political and economic stakes (electoral stakes, power plays, financial interests, etc.) of the elites of terroirs bordering the protected area are not taken into account in the concertation processes, thus leaving little power in the hand of customary authorities and their representatives.

A more equitable model of governance requires respect for customary rights and the rule of law, the promotion of constructive dialogues, equitable access to information, and empowerment of local actors for decision-making (Borrini-Feyerabend *et al.*, 2014). In the case of Zakouma National Park in Chad, only a continuous process of negotiation involving the various local actors would make it possible to identify alternatives to the existing model of management, at least to make the residents understand the rationales behind the zoning arrangements adopted.

Sustainable funding of protected areas for a long-term impact on territorial development

For protected areas to be the engines of economic and social territorial development, predictable and long-term funding is essential. To expand the network of protected areas in line with the Aichi objectives (CBD, 2011), annual funding of between US$ 9 and US$ 85 billion will be required (CBD, 2012) over the 2013-2020 period.

The States' budgetary contributions are an essential element of this funding, in particular to cover recurrent costs. Depending on national legislation, protected areas may benefit from all or part of the revenues from entrance fees and tourist infrastructure, but these revenues are very rarely sufficient to cover financing needs. A few exceptions exist in Eastern and Southern Africa, such as the Kruger National Park in South Africa or the Masai Mara Reserve in Kenya. Income generated by tourism outside protected areas (such as airport taxes, for example) must also be partially allocated to these areas.

Due to insufficient national public funding and direct earmarked revenues, and because they pertain to the protection of a global public good, protected areas in developing countries also benefit from external funding (bilateral and multilateral donors, private funding, foundations, international NGOs). Funds from these entities are primarily earmarked for capital expenditure. If, during the lifetime of a project, international donors cover part of a protected area's recurrent costs, it is essential to ensure continued funding after the end of the project.

To ensure long-term funding of protected areas, so-called 'innovative' mechanisms have been proposed (conservation trust funds, compensation mechanisms, payments for environmental services, REDD+ etc.). The combination of these tools can provide lasting solutions to the funding of protected areas (Fétiveau *et al.*, 2014). However, these mechanisms increase the number of intermediaries and, in so doing, move the decision-making and negotiation centres outside the country, and sometimes even displace the concerned public authority from the management of its own territory's protected areas (Méral *et al.*, 2009). On the other hand, the governance of trust funds strengthens national actors dedicated and committed to the management of protected areas. It shields them from the mistakes of governments which, through short-term necessity or ignorance, accord insufficient priority to the protection of natural capital for future generations.

Box 24.1. Participatory modelling.

In order to improve the coexistence between protected areas and their peripheries, CIRAD and its partners have participated in several initiatives aimed at encouraging the exchange of information and negotiations between local actors involved in the management of protected areas. One of these initiatives is conducted in Zimbabwe through two projects based on the 'Production and Conservation in Partnership' (www.rp-pcp.org) mechanism. It uses participatory modelling of farming practices in the form of a role-playing game to promote information sharing and negotiations between actors.

As part of the ANR-Savarid multidisciplinary project (ANR-11-CEPS-003), which analyzed the socio-ecosystem of Hwange National Park and its periphery in the face of climate aridification, researchers co-constructed a role-playing game with local farmers. The Kulayinjana role-playing game (https://www.openabm.org/model/5221) models livestock husbandry, which is an essential element of (non) coexistence with the protected area, and interactions with the environment and wild animals. After a test phase conducted with village communities in Hwange, the FSP-RenCaRe project (FSP no. 2011-36), which supports the management of protected areas and their peripheries in southern Africa, allowed the testing of Kulayinjana's genericity and utility as a tool for negotiation between actors (forest officials, national parks, traditional authorities, government technical services, etc.), in different agroecological zones and at local/national/regional scales.

Figure 24.1. Session of co-construction of a role-playing game with villagers to improve the coexistence of protected areas with peripheral areas (Magoli village, Zimbabwe).

Conclusion

Issues of protection of nature, when territorialized as in the case of protected areas, tend to confront local actors with external actors whose actions for conservation and development modify the local socio-economic and political fabric, heightening the risk of tensions and conflicts. Provided the conservation rationales take into account the practices and realities of local populations in and around the conservation areas, the expansion of protected areas can nevertheless be an opportunity for territorial development. The inclusion of the conservation project within a larger and inclusive local development project is a good way to enhance its acceptability and strengthen its role as a catalyst for local dynamics.

Box 24.2. The model of transfrontier conservation areas in southern Africa.

Protected areas in Southern Africa, most of them created during colonial times, are home to remarkable biodiversity and landscapes. They play an essential role in tourism and other income-generating activities, and, mainly for these reasons, have been preserved and often even strengthened by post-colonial governments in the region. And yet, local populations continue to be deprived of the benefits of protected areas in most cases. A new protected-area model has been adopted over the last 15 years by number of southern African countries: Transfrontier Conservation Areas (Andersson *et al.*, 2013).

Figure 24.2. Great Limpopo Transfrontier Conservation Area: the boundary between the communal area of Malipati, the Gonarezhou National Park and the hunting zone of Malipati.

The Great Limpopo Transfrontier Conservation Area aims to bring together, within the same management unit, spaces with different and even contradictory uses of natural resources.

They aim to contribute to the preservation of biodiversity, peace and regional integration of countries through sustainable economic development, in particular through tourism and related activities such as game hunting. Transfrontier conservation areas are not limited to the association of several national parks on either side of national borders within the same management unit, but also include large portions of adjacent communal areas.

Even if it is too early to draw any definitive conclusions from these processes, it is clear that the transfrontier conservation areas have not fulfilled all the expectations of the different protagonists in Southern Africa. Even though some problems are not specific to these areas (top-down processes, inadequate consultation with and participation of local populations, human-wildlife conflicts, etc.), others appear to be specific to the model of transfrontier conservation areas and raise questions about its viability:
– increased influence of the international level, which widens the gap between the (local) level at which the socio-ecological processes of interest to these populations take place and the level at which management decisions are made (national or international);
– paucity and volatility of income generated by different forms of tourism.

What is the future for transfrontier conservation areas? It is a difficult question to answer, but the future – if there is one – will depend on a better integration of the local populations in the decision-making processes and an equitable sharing of benefits.

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2-5 – The territory as a basis for designing public policies

Chapter 25

Social learning for territorial development

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Territorial development reshapes public action by involving citizens in the choice, management and monitoring of public services, and by promoting the representation of populations that are usually excluded (Tonneau *et al.*, 2011). The corollary is an engagement by citizens that goes beyond the traditional reliance on political or administrative representatives. However, local actors do not always wish to participate in the territorial governance that decentralization is gradually establishing, nor do they think they have the legitimacy or even the competence to do so. Nevertheless, the appropriation of territorial governance by local actors is essential for the emergence and implementation of dynamic, innovative and sustainable territorial projects. How can they be motivated or convinced to go down this path? Based on the literature and our field experience, we posit that this involvement in development has to be learned and that the research community has an important role to play in this learning process.

Learning for territorial development

Learning, by which we mean the acquisition of new know-how and knowledge that actors can use in the decision-making process (Vitry and Chia, 2016), often takes place in collective contexts. We thus refer to organizational or social learning, which goes beyond the individuals. Research on social learning (Leeuwis and Pyburn, 2002) has shown the importance of creating learning situations, in which actors can go beyond their defensive routines, share their positions, develop unifying ideas, define new common values together and then collectively put them into practice (Coudel *et al.*, 2011; Daré *et al.*, 2010).

To illustrate how social learning enables the inclusion of actors in territorial development, we will draw on two experiences in accompaniment undertaken by CIRAD, in the semi-arid region of north-eastern Brazil and in the mountains of Bhutan (Boxes 25.1 and 25.2). They have resulted in a collective and long-term engagement by the actors in territorial governance mechanisms. Their contexts may be different but common lessons can be drawn from these two case studies.

Figure 25.1A. Action research at UniCampo in Brazil.

Figure 25.1B. Role playing in Bhutan.

Box 25.1. A farmer university (UniCampo) in the Brazilian semi-arid.

In north-eastern Brazil, in the Cariri Paraibano, part of the marginalized region of the *sertão*, UniCampo gradually established, between 2003 and 2006, a training process through action research for 35 rural community leaders, farmers, teachers and agricultural technicians. The objective was to enable them to implement projects adapted to the semi-arid context and to integrate themselves into the new territorial arenas being promoted by the Lula government. By encouraging them to ask key questions such as 'Who am I?', 'What do I want to do?' and 'How do we organize?', the pedagogical path led the participants to progressively construct their individual projects, linked to a group project and a project for the territory. However, after the training, despite significant progress in individual learning, participants found it difficult to get involved into political arenas to defend their projects and their vision of development. The UniCampo Student Association, originally created to ensure the continuation of training, progressively turned into a technical assistance NGO. This gave it a recognized status within the territorial arena consisting of the 31 municipalities of the Cariri region. The links established with the researchers enabled the association to pursue research on its own, in particular in support of the work of agricultural technicians.

(Based on Coudel *et al.*, 2009, 2014)

Box 25.2. A process of companion modelling in west-central Bhutan.

In the Lingmuteychu mountain sub-watershed, a Companion Modelling process (ComMod) (see Chapter 31) was conducted between 2003 and 2005, in two consecutive cycles with first two, and then seven villages, in order to resolve conflicts of access to irrigation water during transplanting of rice. Two participatory modelling and simulation workshops based on role playing first allowed the different types of farmers from the two villages that were most upstream to call into question the water sharing rule in use, given the recent intensification of cropping systems. Nevertheless, in the absence of any formalization, the farmers of the upstream village did not apply the agreement proposed for the transplanting of 2004. The local research community then proposed an extension of the process to the next seven villages. A second round of simulation workshops, based on a second role playing game and a multi-agent computer simulator playing it *in silico*, explored the possible scenarios. Encouraged by a strong political will to decentralize water management, the interactions between village officials and the local research community resulted in the creation in 2005 of a sub-watershed management committee, formalized through a statute and hard-fought regulations. This inter-village institution, supported by the local branch of the Council for Renewable Natural Resources Research of Bhutan, has gradually been empowered and has diversified its action plan with funding from the United Nations Development Program.

(Based on Gurung *et al.*, 2006)

Some lessons learnt

Learning through a research process: expliciting knowledge, feeling valued, developing reflexivity

Learning was fostered by the existence of heterogeneous collectives in which the actors were engaged in reflexivity throughout the accompaniment process. Through contacts with the researchers, the actors were able to explicit their local knowledge or uses, assumed critical postures and stimulated their collective imagination. In the case of UniCampo, the key questions helped farmers problematize their reality, conduct research and experiment. In Bhutan, two role playing games and then a multi-agent computer model enabled a discussion on the different representations of reality, and then simulated the effects of potential new management rules. In this way, the actors discovered that their knowledge is wide-ranging and legitimate, they felt valued by the attention of the researchers and were pleased to build new complex knowledge (zoning of the territory, multi-agent model).

Promoting communication and exchange to build a shared vision

The assessment that followed the accompaniment revealed that the actors found the learning related to communicational and relational aspects especially valuable: understanding the other participants' vision, knowing how to position one's own vision, knowing how to discuss topics with others and how to build a shared vision. It was this pathway, the process to achieve a common goal, which was emphasized. Indeed, the actors, although all farmers, had quite varied concerns. Discovering the point of view of the others led them to a better perception of the territorial issues and possible solutions, sometimes observed elsewhere in the territory, including issues of water management, practices to limit erosion or insertion in particular supply chains.

Putting learning to the test of time and territory

Although the shared vision was swiftly translated into concrete proposals, implementation was more difficult. Initially, at the end of the first training or modelling cycles, the actors were frustrated by their inability to implement their learning on a territorial scale. But, thanks to the knowledge acquired during the accompaniment by the research community, they learned to organize themselves to assert their positions. For example, the UniCampo association helped former participants disseminate within the territory the technical knowledge they had co-constructed with the researchers. These organizations did not resolve all the difficulties, but they did help actors seize opportunities offered by decentralization and new legislation.

Overcoming difficulties is an integral part of learning

Social learning is a dynamic and cyclical process, born in action and in the alternation of phases of problem framing, knowledge sharing, experimentation and observation of results. In fact, dealing with difficulties was of fundamental importance in stimulating learning 'by reaction' and in engendering a real engagement of the actors in the territory. But this learning was possible only because it could rely on knowledge that

was explicitly formalized (key questions in Brazil, modelling in Bhutan), on improved abilities of sharing, on the common vision that emerged and, above all, on the new legitimacy of the actors which has endowed them with a 'power to propose' solutions for the management of their territory (Balandier, 1988).

Relying on networks to legitimize solutions for the territory

Thus, the network that the participants created during the accompaniment process, between themselves and with different research and development institutions, facilitates their involvement in the life of the territory. In the case of UniCampo, the legitimacy of the proposed technical models is based on scientific knowledge, built with the researchers, and on the social demand conveyed by the farmer leaders. In the case of Bhutan, the research community enabled contact with the United Nations Development Program (UNDP), which financed their first action plan and guaranteed the sustainability of a microcredit institution.

Outlook: increasing the capacity of learning for territorial development

The social learning that emerged in these two experiences made it possible to perpetuate the dynamics initiated beyond the involvement of the researchers. However, it must be noted that this involvement lasted three years, a period necessary for actions of accompaniment and for carrying out a complete learning cycle.

If the accompaniment is insufficiently anchored in the territory's realities, there is a high risk of falling short of expectations and of demotivating the actors, which is inconsistent with the objective of their integration into territorial dynamics. By positioning themselves with regards to the other participants and interest groups, actors learn to manage the inevitable tensions and conflicts that are part of any territorial process.

To facilitate such anchoring over the long term, favourable learning conditions have to be created through, on the one hand, a close relationship with researchers, leading to trust, scientific rigour, reflexivity, cross-legitimization of knowledge and the setting up of networks of various actors (Jankowski and Le Marec, 2014), and, on the other hand, the insertion into situations in which the learning is put to the test of reality. These conditions favour the progressive integration of the actors in territorial development and its institutionalization, through the legitimacy they have in creating organizations and proposing solutions. Accompaniment efforts can then continue within the governing and adminstrative bodies in order to extend learning situations to them (Tonneau *et al.*, 2011, Daré and Venot, 2016).

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Chapter 26

Diversity of actors and alliances in processes of territorialization

Sarah Audouin and Denis Gautier

Processes of territorialization and new territorialities

The terms territory, territoriality and territorialization are often used interchangeably and without uniformity across the geographer community (Vanier, 2009) to designate relationships between individuals or within collectives for the access to the management and control of physical resources (natural, infrastructural) or intangible ones (cultural, heritage, etc.).

We define the territory here as a space appropriated by a society with the conscious feeling of this appropriation (Brunet *et al.*, 1993). It is an arena for the exploitation and management of resources and thus brings together, in a sometimes conflicting, sometimes harmonious way, a set of institutions and actors between whom power relations are established with a view to controlling access to space and resources. In theory, the use and management of natural resources are regulated in a given territory by an entity in charge of doing so. This entity therefore controls humans and resources within the boundaries of that territory (Sack, 1986). It may be an authority that is customary (village), decentralized (municipal), deconcentrated (meso level), central (the State) or even a private group which the central government has authorized to govern a given space, in accordance with resource management rules.

In practice, with the exception of situations in which the central authorities retain most of the control over land and the management of natural resources or, conversely, those where the processes of decentralization or privatization are well advanced, these different types of entities coexist, in charge of more or less delimited territories and using more or less established methods of governance (Bassett and Gautier, 2014; Gautier and Hautdidier, 2012). This superposition of territories in the same physical space results in subtle games that actors play to secure their rights of access to space and resources, in a context in which several territorialization processes coexist and in which new territorialities emerge.

The processes of territorialization thus encompass these interactions between actors. By the process of territorialization, we mean the creation and maintenance of

portions of space within which certain practices are permitted on the basis of explicit or implicit allocation of rights, of control and of managerial authority (Peluso, 2005). The territorialization of a space aims to impose rights or to circumvent those of other competing actors, or, failing that, to rely on different methods of governance associated with different types of territories depending on the interests of the actors. The power games between actors for access to space and the resources in it are therefore an essential part of the processes of territorialization.

Finally, territorialities are defined as the socio-spatial relationships and alliances resulting from the methods of resource management, actions, practices, motivations, intentions, personal histories and cognitive representations leading to the construction of territories or to their reshaping (Gonin and Gautier, 2016). These processes are the result of alliances or conflicts between assemblages of agents (Li, 2007), driven by their interests, arguments and discourses, which reflect the issues of powers and practices, and lead to a redefinition of the rights of access to resources. The actors thus use rules of governance established within the framework of territories or form alliances between themselves to establish new territorialities (Gautier *et al.*, 2011). The game of socio-spatial relationships and alliances between actors is thus essential for consolidating territorialities, reshaping them or creating new ones, as an example from south-western Burkina Faso shows.

The example of cashew plantations in south-western Burkina Faso

Among the alliances formed between different types of actors in a process of territorialization, those established between local actors are most frequently encountered in our field studies. The main example we will present here is that of the process of territorialization at the village level in south-western Burkina Faso around smallholder cashew plantations (Audouin and Gazull, 2014). The State indicated its willingness to develop this sector, first in 1960 by the introduction of seeds from Dahomey (now Benin) and then by the creation in 1980 of plantations with the objective of boosting production and encouraging local processing. Despite the best intentions of the government, smallholder cashew plantations, started with seeds from these government plantations or from individual initiatives of pioneering farmers, remained marginal until 1995. Subsequently however, cashew cultivation has increased substantially since the arrival in West Africa of Indian raw nut buyers who saw the potential of production in the region to meet the growing global demand for cashew nuts. The expansion of cashew cultivation was initially carried out by local actors belonging to the founding lineages of the villages and with secure access to sufficient land. In contrast, in some village territories the expansion of cashew cultivation has been reinforced by returning farmers who had migrated to Côte d'Ivoire and had gained experience in growing perennial crops for export and who have been allocated land by the local customary authorities. These alliances between migrants and customary authorities made it possible to form cashew production clusters that present attractive economies of scale to export enterprises. These plantations at the village level have now been replicated throughout the south-western part of the country (Cascades and Hauts-Bassins regions), thus increasing its commercial appeal.

This process of territorialization through the cultivation of cashew nuts is therefore based on alliances between farmers and village customary authorities, with the benevolence of the State which chooses not to oppose these farms, even if the cashew tree durably marks an appropriation of non-cadastral land that still belongs to the State. The cashew sector is now well on the path of being structured through producer organizations that are coming up at different levels (municipalities, region, nation) and which are capable of interacting with the central government and processing companies. However, this process also has negative effects on the territorialities of other actors. At the local level, in some territories, the poorest households (recent migrants or older households not belonging to the founding lineages) find themselves excluded from these processes because the right to plant is denied to them. Women are also on the losing side in this process of territorialization. Only a very small number of them benefit from the seasonal activity of artisanal or semi-industrial processing of nuts which covers only 5 to 10% of the nuts harvested. Most importantly, the expansion of cashew plantations to the detriment of scrublands result in the loss of the women's access to the vegetation areas which represent a safety net for them during the lean season. They can no longer collect wood and Non-Timber Forest Products, for ensuring their direct or indirect food security (Koffi *et al.*, 2016). Finally, the regional routes followed by Fulani pastoralists during transhumance are blocked by these plantations and conflicts often erupt in areas in which they had become accustomed to grazing their livestock in the dry season (Audouin and Gonin, 2014).

Interplay of territorial alliances between actors

In the example of the cashew nut sector, local alliances redefine territorialities and rights of access to space and resources. In particular, they exacerbate the inequalities of access to resources between actors in the same village and between different actors of the sector. The losers in these territorialization processes are the actors with the weakest entitlements – understood as the totality of things that an individual can obtain according to the rights he holds (Sen, 1999). They are therefore obliged to come up with new adaptive strategies to compensate for the loss of their rights to access the land and natural resources associated with cashew plantations. This may lead them to circumvent the new rules of access by planting trees, either without authorization or in a neighbouring village with more flexible rules, by diversifying their activities to compensate for restrictions on land access, or by attempting to become part of the alliances of dominant actors behind this redefinition of territorialities.

The same type of alliances between actors whose aim is to redefine the conditions for access to land and resources is found in Burkina Faso and more generally in the sub-region. Similarities can thus be found between the example of cashew cultivation and the globalized shea nut supply chain (Rousseau *et al.*, 2016) or regional woodfuel chains (Gazull and Gautier, 2015). In these cases, it appears that assemblages of actors aiming to create development territories can produce what appears to be a success on a global or national scale, but which often leaves a certain number of actors more vulnerable or less well organized on the margins of the process and the development that it generates. While it is understandable that these processes are tolerated and even

encouraged by the central, decentralized or deconcentrated State, the public policies that accompany them must remain vigilant. The secondary effects engendered locally by power games can indeed reshape territorialities and make the actors excluded from these alliances more vulnerable and often less concerned about preserving their environment. Given these observations, research for development must be able to guide and accompany the various actors of the territorialization process in progress (administrative authorities, producer organizations, local authorities) in order to anticipate these changes in a perspective of inclusive sustainable development.

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Chapter 27

Towards a territorialization of rural policies in Tunisia: the example of water and soil conservation policies

Aurélie Chevrillon, Naoufel Ben Haha and Julien Burte

Ever since Tunisia gained independence, the country's agricultural policies, as formulated by the Ministry of Agriculture, Water Resources and Fisheries (MARHP), have consistently focused on the management of natural resources in various development plans and strategies (AFD, MARHP, 2015). The approaches have gradually developed over four major periods (Figure 27.1): from construction of infrastructure to structural adjustment and the disengagement of the State in order to empower local populations and cut spending, from very vertical and sectoral approaches to more inclusive and participatory ones. International donors have played an important role in the choice of orientations post the 1980s, with a majority of the State's policies being financed by loans.

Despite these developments, the degree of public participation in public policies remains very limited and functional institutional organizations in rural areas are far and few between. This limits the benefits of State agricultural policies. For example, there is an accelerated degradation of water and soil conservation facilities constructed by the General Division of Planning, Management and Conservation of Agricultural Lands (DGACTA), given the low participation of the local people in their maintenance. In spite of a decent growth rate of Tunisian agriculture since the end of the 1980s, with an average in excess of 3% (AFD, MARHP, 2015), the slowdown in development, with a drop in the standard of living in rural areas in comparison to urban ones and in the country's central areas in comparison to coastal areas, remains an issue of concern.

The Tunisian revolution has highlighted the fact that the Tunisian State can no longer address the major challenges of development and conservation of the natural resources of rural areas without any real involvement of the local populations. In this context, in 2016 DGACTA adopted an innovative approach to the concerted formulation of its new water and soil conservation policy.

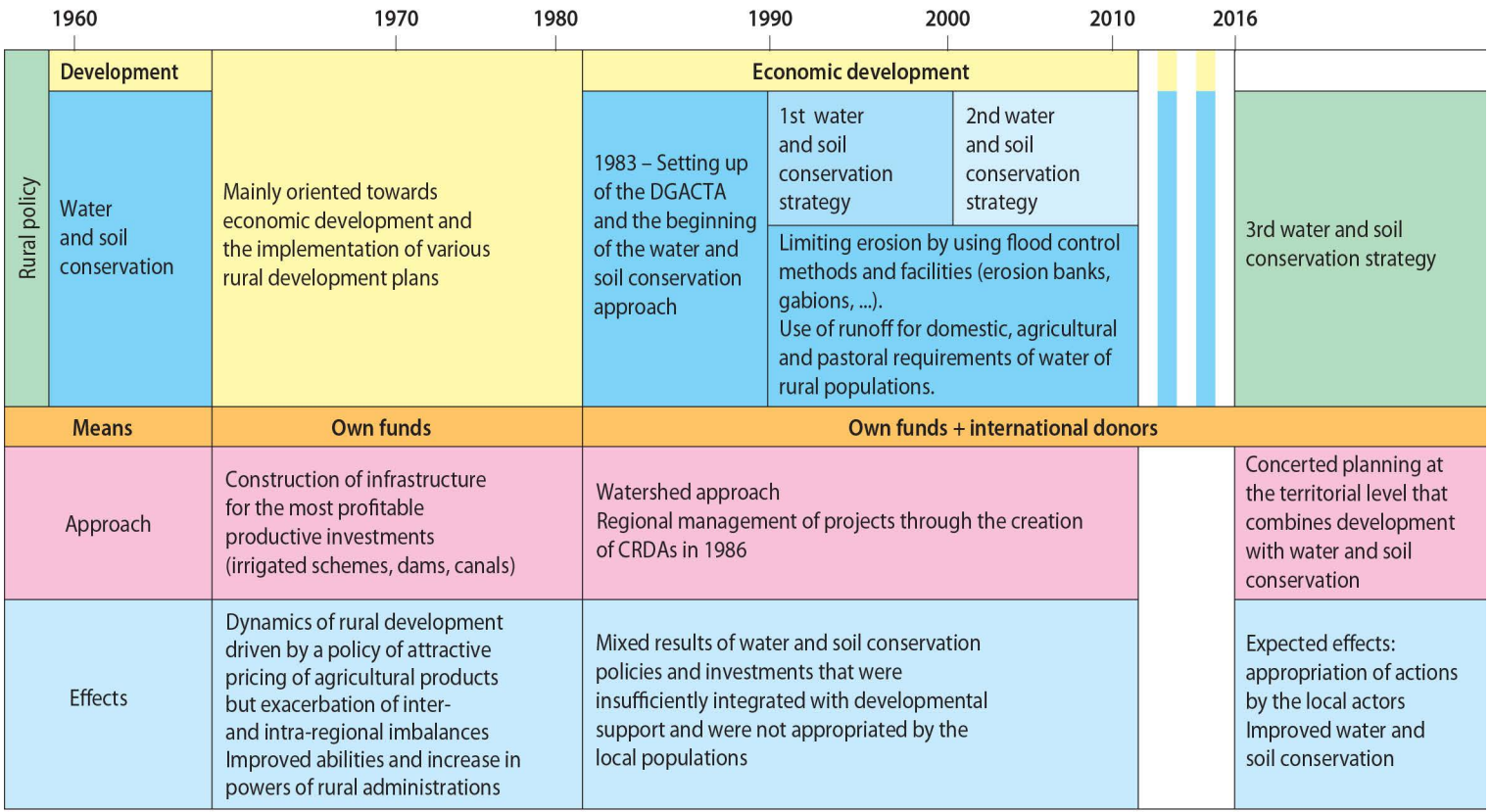

Figure 27.1. Water and soil conservation policies in Tunisia: their place in rural policies, changes in their scopes of action, modes of financing, approaches and effects.

In this chapter, we analyse this policy through the historical development of its action and the positioning of the various partners in this initiative – development donor (AFD) and research and higher education institutions (Inat, CIRAD, etc.). This approach is gradually leading all these institutions to modify their respective action frameworks, whose modalities are often unsuitable for territorial concertation.

Multi-sectoral watershed planning: a step forward?

The use of renewable water resources, in excess of 90% in Tunisia (AFD, French Ministry of Agriculture, 2011), the low efficiency of their use and unsuitable practices have led to overexploitation of groundwater in several regions, and to the salinization of groundwater and soils. Furthermore, water availability is expected to be affected in the future due to climate change, in terms of both its quality (salinization) as well as its quantity. It is estimated that by 2030, the total water availability (all sources combined) will fall by around 15% (Euronet Consortium, 2012). The intensification of agriculture and certain practices (deforestation, tilling on slopes, overgrazing of 80% of rangelands, etc.) have also led to a significant deterioration of agricultural land and vegetation cover (erosion, loss of organic matter, thinning of plant cover, etc.), exacerbated by sloping reliefs and irregular, erosive precipitation. Such land degradation invites flooding and landslides during heavy rains, affecting ecosystems and threatening infrastructure (dams and roads in particular). This situation has a direct impact on agricultural productivity (reduction of soil fertility), on the environment (most notably an increase in the use of fertilizers to offset the effects of erosion) and on the State budget (increased spending on infrastructure revival).

Funding watershed management was one of the main programmes of DGACTA within the framework of the implementation of its second water and soil conservation strategy (2002-2011)[1]. It was financed by the AFD and the Tunisian government, and its objective was directly linked to those of the Ministry of Agriculture, Water Resources and Fisheries and of the Government[2] for a sustainable management of natural resources. Through this programme, DGACTA has sought to propose a new framework for action, based on the integration of sectoral approaches at the watershed level and the promotion within regional agricultural services of participatory development programmes such as for the design of concertation and planning processes.

This action framework was designed to ensure that the multi-sectoral nature of the challenges and needs of the territory/watershed was taken into account (improved access to social services such as drinking water and education, natural resource management by the physical organization of the environment, opening-up of interior production areas, etc.). It was then meant to be rolled out through the establishment of organizations of local populations and by their participation in the formulation and

1. The first soil and water conservation strategy was formulated at the same time as the Tunisian decentralization law of 1989 and resulted in the creation of regional commissions for agricultural development. Subsequently, the integrated participatory approach (IPA) gradually became the focus of most major rural development projects in Tunisia.

2. The Xth Plan and, in particular, the XIth Plan (2007-2011) emphasize the objective of sustainable management of natural resources.

implementation of participatory development plans (GDA and CDL). In reality, the expected results have not been achieved. The administration's sectoral organization and functioning, whether at the national level (between different divisions of the Tunisian Ministry of Agriculture) or regional level (difficulty of cooperation between administrative districts), prevented the articulation and coordination of development actions at the regional scale. While the project envisaged participation from stakeholders, in practice this was limited to a single consultation in the absence of factors that would have required greater participation (no consideration of different viewpoints, no shared access to essential information, lack of transparency in decision-making processes and the role of various actors, etc.), and the fact that the decision-making power lay with the administration. Moreover, the low level of institutionalization of the Tunisian rural environment, which was barely considered in the process, is an important factor that explains the difficulty in bringing together farmers and other territorial actors.

Thus, without territorial anchoring, planning at the watershed level, which should have been organized around socio-territorial units, has, in effect, ended up as planning by the administrative sector, reflecting a typically public character of the approach and its still overly directive orientation. The people thus mainly sought to obtain investments that were of interest to them: negotiating for socio-sanitary and educational infrastructure instead of facilities for the physical environment (anti-erosion works, reforestation, small reservoirs, etc.); rejection of such water and soil conservation facilities, and negotiating instead for the implementation of other facilities, most often socially oriented ones.

The turning point of the revolution of 14 January 2011

The revolution of 14 January 2011 marked a turning point in the attitude of the rural population, which thereafter consciously refused the imposition of any project planning by the Tunisian administration. This new socio-political context left DGACTA with two options:

– a fallback scenario consisting of considering as irreversible the non-validation of the participatory basis of its planning process and focusing all action on traditional water and soil conservation efforts, over which the regional agricultural services had good mastery. But this scenario proved increasingly inappropriate as the project concerned the most socially fragile areas;

– a constructive and forward-looking scenario that called for the strengthening of the dynamics of territorial development.

In this context, DGACTA began preparing its third water and soil conservation strategy in 2014 and a new programme (PACTE), drawing partly on the experience of the funding framework for watershed management. It was a matter of proposing a completely new approach, as much in form (a clear choice of an effective territorial concertation within a decentralization process) as in substance (choice of systemic approaches combining natural resource conservation and economic development)[3].

3. These activities will assume the form of development plans (forestry, pastoral, protected areas) defining the rules of use, physical investments, techno-economic consulting services and land facilities.

A partnership framework between the Tunisian Ministry of Agriculture (represented by DGACTA), the French Ministry of Agriculture, and Tunisian and French institutions for research and higher education was developed with aid from AFD in order to support this innovative territorialization of the water and soil conservation policy.

The aim of this new programme is to conduct tests in a dozen territories, ranging in size from 150 to 200 km^2, to arrive at a better integration of natural resource management activities, by developing and implementing territorial agreements which will cover facilities for the physical management of the environment. The management of natural resources is understood here in the broad sense, i.e., involving not only the protection of resources, but also their exploitation. The aim is also to adopt an approach to integrate natural resource management activities at different scales, from the landscape to the plot. A number of structural facilities, whose scope extends beyond the local level, may involve centralized planning carried out by the regional administration. The programme's scope of intervention within watersheds not only includes degraded agro-pastoral areas subject to erosion, which are the preferred areas of intervention of DGACTA, but also forest lands usually located upstream. At the local level, the territorial agreements will be developed within socio-territorial units determined by the identification of the territories of life, corresponding to the territory in which a given population sustains social relationships, conducts its day-to-day economic activities, shares a common stake in the management of a particular natural resource and/or organizes itself into a group, association or professional organisation (Di Méo, 1999).

This approach presents major advances in comparison to previous public policies:
– it pursues an objective of perpetuating institutional spaces for territorial concertation involving all the actors. The aim is to create institutionalized concertation platforms involving the territory's actors[4] and national, regional and local institutions. These platforms are based on the drafting of territorial agreements which will cover the programme's investment objectives and modalities. A continuous steering of the platforms is ensured by small, dedicated local and regional administration teams (regional development support officers). The concertation body is the territorial committee composed of representatives of local actors (one third), of the administration (one third), of elected representatives (one sixth) and of civil society (one sixth). The approach envisages an association of existing formal or informal local institutions: in order to anchor the mechanism to the territory, it is necessary to take into account the informal structuring of the Tunisian rural space socially built into territories of life, and set up a representation of these territories of life within the territorial committee; at the level of the economic sectors and social organizations, it is necessary to associate representatives of supply chains and NGOs;

4. Local actors are defined here as non-administrative actors who live or act on a continuous basis and are anchored in the territory, i.e., the local population as a whole – inhabitants of the territory, civil society organizations, actors (farmers, livestock farmers, foresters, etc.) or professional groups of actors (GDA, SMSA) contributing to the development of local natural resources, actors of chains, associations, local elected representatives. One of the challenges of the approach will be to allow the emergence of legitimate representatives of these local actors who can participate actively in the formulation of a strategy for the development and conservation of natural resources. The idea is to rely on existing formal or informal institutions or to encourage their emergence.

– it decentralizes decision-making power by recognizing the legitimacy and shared responsibility of its members in decision-making and in supporting the implementation of plans. Collaborative planning then becomes a continuous and iterative process, based on the gradual improvement of skills and increase of knowledge within the mechanism which, in this way, progressively strengthens its legitimacy;
– it is based on the setting up of a participatory and sustainable mechanism for observation, monitoring of the territory and sharing of information to help the actors in their decision-making and enable them to better fulfil their respective roles in the territory, in order to improve the development and management of natural resources. This mechanism, which can be described as a territorial observatory (Lemoisson and Passouant, 2012, Chapter 34), brings together Tunisian research and education institutions (INAT, INRGREF, etc.) and their French partners (CIRAD, Irstea, IRD, etc.). Through their training and research activities, the latter contribute to the processes of production and the sharing of knowledge and information. The hypothesis is that the production of information and knowledge by and for the territory's actors contributes to the process of territorialization and reinforces it.

Important challenges for all actors in the process

For the administration, the first challenge is to enable and support the existing skill sets of agents in order to help them develop as versatile managers/facilitators of the concertation process. It is also a matter of equipping local actors, at the levels of their territory of life and the territorial committee, with the means and skills required to appropriate and co-construct the territorial project. This requires a gradual empowerment and autonomy of populations, which implies a major change in the attitudes, both theirs and the administration's. It also requires a change on the part of higher education and research institutions, which normally do not involve development institutions and local actors in undertaking research or training activities.

Finally, AFD needs to accept an iterative and evolving planning process, whose results may be unpredictable at the programme's launch. This approach also marks a break with the traditional distinction between physical investments (water, soil and forest conservation facilities), which are thought to be economically profitable and are therefore capable of backing loans, and supporting actions (agricultural advisory system, training), whose results are less predictable and whose profitability is more difficult to evaluate.

The challenges of the process of territorialization of the water and soil conservation policy

A historical analysis of the development of State policies for water and soil conservation in Tunisia by DGACTA helps explain its reorientation towards a territorialization of public action and, more generally, towards a dynamic of territorial development.

Since 2014, the multi-institutional and innovative partnership framework has been working to build a space that brings together the donor, developers, research institutions and local actors in a joint structuring process. This dynamic is based on a strong

commitment from these different actors who are prepared to work in a process that integrates a part of the risk and whose results are not entirely predictable. Institutional inertia and sectoral issues (of the Tunisian State, the main donor and its funding rules, research institutions, French partners), the paternalism of a vertical socio-political organization inherited from 50 years of dictatorship, the many unknowns of an unfinished process of democratization and decentralization, the very disparate objectives of the various stakeholders and, above all, the challenge of placing local actors at the heart of the approach are all factors that will have to be taken into account in the design and conduct of this process of territorialization of the policy for water and soil conservation.

Finally, one of the main lessons of this diachronic analysis is that the legitimization of public action in Tunisia (particularly in the rural territories of the central governorates) necessarily involves a renewed dialogue with local actors and, even more importantly, the recognition by the State that the rights and responsibilities of local communities, as well as their legal and real capacity to exercise them satisfactorily, are at the heart of issues regarding conservation, development and sharing of the benefits of natural resources.

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Chapter 28

The policyscape as a conceptual framework to study the combination of conservation and development policies in the territory: the case of Mexico

Driss Ezzine-de-Blas and Céline Dutilly

Mexico was one of the first countries in Latin America to implement a national programme for payments for environmental services (PSA-H) to protect forests that play a role in regulating the country's hydrological services (Muñoz-Piña *et al.*, 2008). Since 2003, this programme has covered more than 2 million hectares of forests through contracts between the government – as represented by the National Forestry Commission (Conafor) – and rural communities. Under the terms of the contract, the latter undertake to conserve forests in exchange for annual payments for five years. The programme has cut the deforestation rate by some 45% and has also contributed to reducing the poverty of the participating families (Alix-García *et al.*, 2015). The programme's professed aim, in the course of its implementation, is not only to curb deforestation, but also to provide an alternative for rural development in marginal forest areas.

Attempting to achieve two objectives with one instrument constitutes a problem of policy configuration that depends on the territory's dynamics of governance and socio-ecological characteristics (Tinbergen, 1956). A set or mix of policies is needed when – as in the Mexican rural context – several constraints and uncertainties affect the implementation of the programme, such as conflicts over property rights, behaviour that imperils the programme, or inadequate State access to information (Goulder and Parry, 2008). The spatial expression of this policy mix in the territory – protected areas, payments for environmental services, support for forest management and community enterprises – is known as the policyscape (Barton *et al.*, 2013). However, the application of a political instrument in a territory is not a purely technocratic and aseptic process: the multi-level governance of the concerned programme is also part of this policyscape. In particular, even though the role of intermediaries or rural technicians is fundamental, it is poorly known: their choices will steer the

spatialization of the programmes, for example, via the selection of participants (Schomers *et al.*, 2015). Moreover, the spatial distribution of an instrument evolves during the different phases of a public policy cycle (Primmer *et al.*, 2011) with adaptations made by various actors as and when they are included in the decision-making space (Alix-García *et al.*, 2015). In this chapter, we present a study of a case which is implementing the concept of the decisional landscape in the course of a public policy cycle, using the example of Mexico's PSA-H. Our presentation here is limited to the salient points of a larger research study (Ezzine-de-Blas *et al.*, 2016).

The policyscape in a multi-level governance

To understand the multi-level governance of the Mexican PSA-H programme, we must explore the articulation by government and non-government actors of their various interests in the course of the policy cycle (Figure 28.1). The definition of the objectives and the configuration of the rules of operation, the identification of funding sources and the implementation of the programme are phases of the policy cycle determined by formal and informal governance networks, where informal spaces for alliances and negotiations will determine their outcome (Mermet, 2011). In the case of the national PSA-H programme, multi-level dynamics are involved in three successive phases: the selection of eligible areas, the definition of selection criteria and the choice of community forests that will submit applications to Conafor. Eligible areas of the territory are the spatial corset from which communities can potentially apply to the programme.

Subsequently, the forest plots submitted to Conafor are evaluated using a points system that classifies the applicants. The selection criteria are determined at the federal level by a multi-actor commission composed of public, private and civil society organizations. Negotiations to configure this system, which ranks the programme's community forests, pits one group of actors who wish to prioritize economic efficiency criteria (risk of deforestation, hydrological vulnerability) against another that lays stress on social and environmental criteria (poverty indicators, presence of community development plans, biodiversity corridors). This confrontation resulted, between 2006 (the year of setting up of the commission) and 2010 (the year of consolidation of the criteria), in a significant reduction in the economic criteria in favour of social and environmental criteria; the latter now account for 80% of the total rating weightage as against 56% in 2006 (Muñoz-Piña *et al.*, 2011). Finally, rural technicians are responsible for submitting the community applications to Conafor, so it is their choices that ultimately determine the socio-economic and ecological characteristics of the territory where the payments will take place.

The consequences of the choice of selection criteria at the national level to address the risk of deforestation

Using a national survey of 324 farming and forest communities, Ezzine-de-Blas *et al.* (2016) analyze how PSA-H fits into the mix of development and conservation policies in terms of the threat of deforestation, a spatially explicit variable, and how

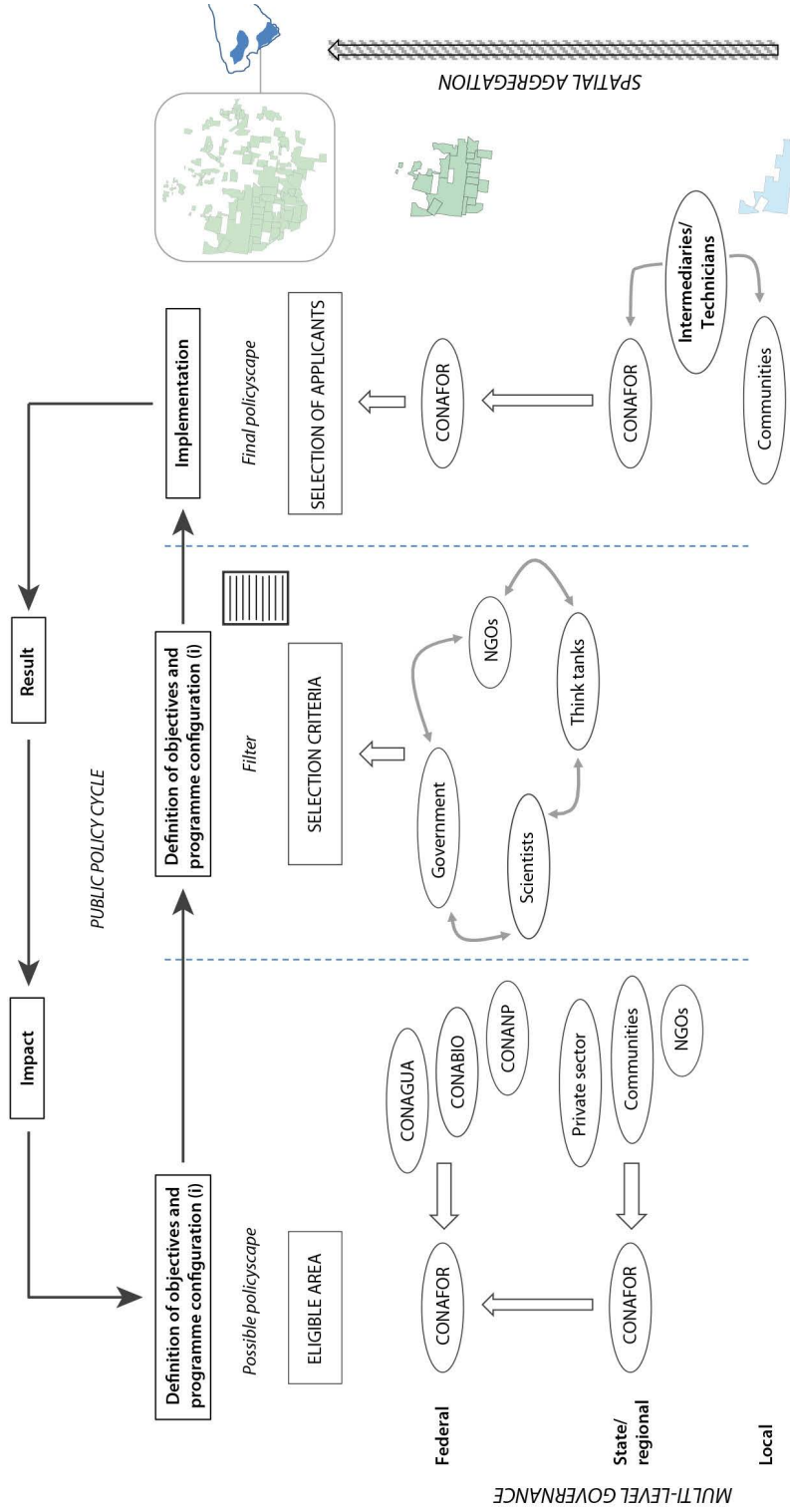

Figure 28.1. The multi-level governance of the national PSA-H programme during the public policy cycle.
Sources: authors, adapted from Primmer *et al.* (2011).

indirectly this rating system influences its positioning. Programmes identified in the survey were: support for traditional maize cultivation (Procampo), for health care of animal herds (Progan), for reforestation and soil restoration activities in forest lands (Procoref), for forest management (Prodefor), the national programme of payments for environmental services (PSA-H) and protected natural areas. The statistical classification by disjoint sets identified three distinct policy-mixes: the first (C1) groups together Prodefor, Procoref and PSA-H, all associated with the national forest support programme (ProArbol); a second group (C2) includes communities in protected natural areas, most of which benefit from the PSA-H; a third group (C3) includes communities benefiting from programmes for support of livestock herds (Progan) and for the restoration of degraded forest lands (Procoref); and the last group (C4) includes communities that only benefit from agricultural support (Procampo), with or without support for livestock husbandry. The agricultural support programme benefits family farming in all communities. The probability of finding a set of forest and environmental policies (C1 and C2) decreases as the risk of deforestation increases (Figure 28.2). In a corresponding manner, agricultural policies are more likely to be implemented when the risk of deforestation increases (C4). Finally, the combination of productive and restoration policies (C3) is less dependent on the risk of deforestation.

Environmental policy-mixes (C1 and C2) are associated with forest territories where these mixes are economically attractive, i.e., with low opportunity costs. This outcome is not only a result of the financial inability to include forests with a high risk of deforestation, but also of the control over selection criteria that accords priority to social and environmental indicators, which are more often associated with forest communities with a reduced risk of deforestation.

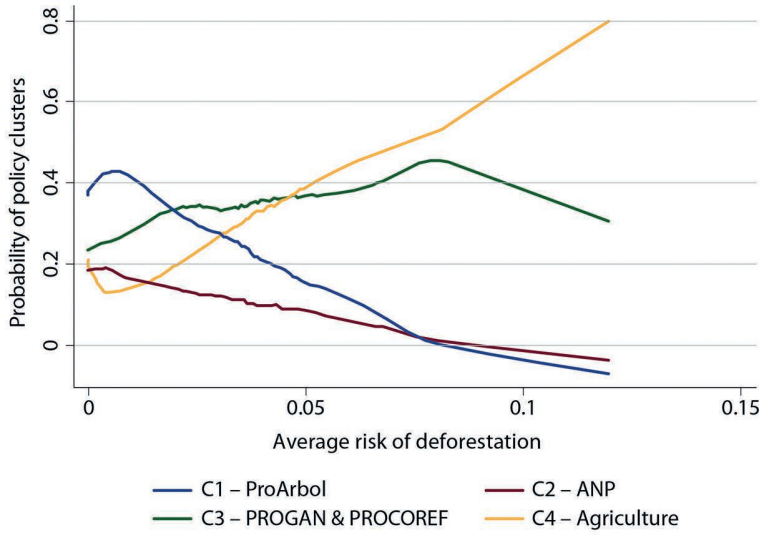

Figure 28.2. Overlapping combinations of forest and agricultural policies as a function of the risk of deforestation.

Sources: authors with data from Ennaf (2011).

The evolution of regional eligible areas and the role of rural technicians

The eligible areas are determined at Conafor's national headquarters on the basis of spatially explicit geophysical data (slope, type of vegetation, hydrology, forest density) and socio-economic data (presence of cities, poverty level, hydraulic infrastructure). These eligible areas must have the approval of other competent governmental commissions, including the National Commissions for Water (Conagua), Biodiversity (Conabio) and Protected Areas (Conanp). These areas have undergone numerous fluctuations resulting from the intersection of many interests. Yucatán and Chiapas States are examples that illustrate these fluctuations which are mainly grouped into three periods (Figure 28.3). In the first period (from 2004 to 2006), the eligible areas were selected on the basis of technical criteria in line with the priorities of the World Bank (proximity of cities for creating markets for environmental services), of Conanp (presence of protected areas) and of Conagua (presence of large forests in aquifer recharge zones). The second period (from 2007 to 2009) was characterized by an expansion of the eligible areas towards poor areas at the urging of the then Mexican President, F. Calderón. Finally, the third period (from 2010 onwards) has seen administrative criteria on the ascendant, driven by pressure from budgetary cuts: areas allocating payments for hydrological services and for biodiversity conservation are being combined under a single call for projects, while areas that made no applications in recent years were eliminated.

And yet, the choice of communities also depends on the strategy of rural technicians, which can partially be perceived by comparing the communities finally selected with those that are eligible. This comparison shows that, for Chiapas State, communities that did roll out PSA-H have more forests, are more frequently associated with protected areas, and have a lower risk of deforestation than unselected but eligible communities. In Yucatán State, the participating communities have lower population densities and tend to be poorer. There is no statistical difference in the deforestation risk.

We compared these results, through interviews with rural technicians of the two States, during feedback and taking-stock workshops of the Pesmix project. In Yucatán, rural technicians are organized mainly in the form of small consultancy firms specializing in rural development. These technicians prefer working with sparsely populated communities that enjoy good governance and large forests that are not threatened by infrastructure projects. In Chiapas, technicians tend to originate mainly from conservation NGOs that are very influential in protected areas where they have historically supported local communities. These two strategies illustrate how the behaviour of rural technicians is oriented not only on minimizing transaction costs (information retrieval and negotiation with the community) (Schomers *et al.*, 2015), but uncertainty factors as well (which can generate unexpected sources of transaction costs) such as social conflicts related to poor programme governance within the community. Ultimately, these targeting and selection processes explain the differences in the characteristics of the communities participating in PSA-H in relation to all eligible communities and their spatial distribution. While communities that have obtained PSA-H are represented throughout the Chiapas State, the communities implementing PSA-H in the Yucatán State are concentrated in the south (Cono Sur region), leading to a

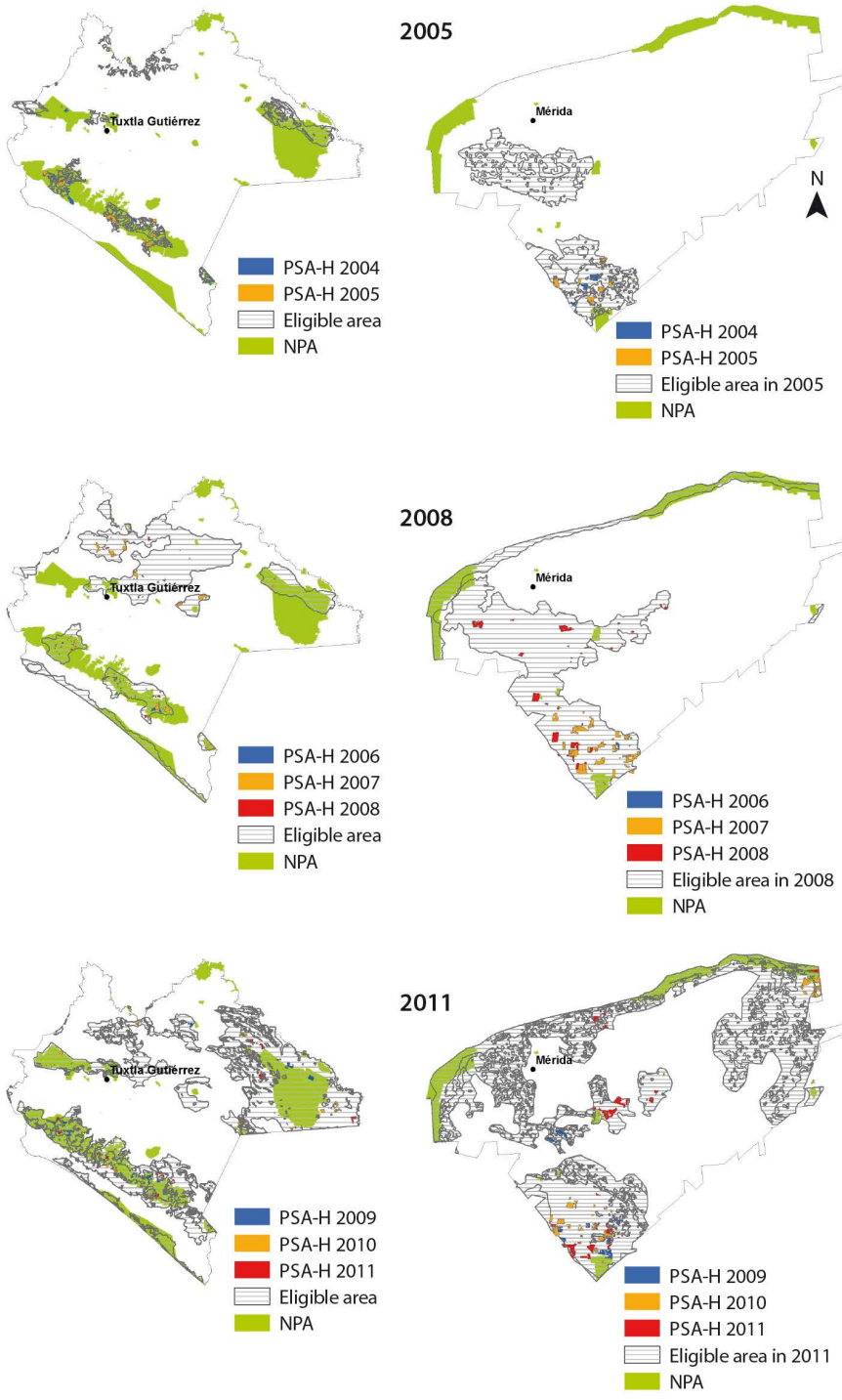

Figure 28.3. Evolution of PSA-H eligible areas (shaded) in Yucatán and Chiapas States.
Sources: authors with Conafor data.

policyscape with a mix of instruments that is quite different from the initial landscape. We should therefore expect the likely impacts of PSA-H programmes – whether or not they are associated with other programmes – to depend on this aspect.

The territory as a witness of and trigger for rural policies

This case study illustrates how the interactions between political and territorial instruments act in both directions: on the one hand, the multi-level governance of PSA-H unites different actors around a series of political objectives, while, on the other hand, the territory's socio-ecological characteristics orient these policies towards specific areas of the territory. Protected forests in the mountains of Chiapas, much like the humid forests of the limestone plains of southern Yucatán, present specific characteristics of agricultural production or their populations that influence the impact of PSA-H and determine the policy mix that is implemented. The PSA-H thus appears to be, just like the conservation and development policies that accompany it, the outcome of a lively and dynamic interaction between the multi-level governance system and the territory, with a constant feedback mechanism at work.

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Chapter 29

The challenges of territorial governance: the example of rural Brazil

Marc Piraux, Jean-Philippe Tonneau, Éric Sabourin, Eduardo Chia, Márcio Caniello, Étienne Polge and Gilles Massardier

Brazil's territorial development policies are now a worldwide benchmark. This is especially true of its National Programme for Territorial Development (Pronat) created in 2004 by the federal government. This programme was intended to encourage investment in family farming in the most marginalized territories through the setting up of collective facilities. In this approach, territorial development is considered primarily to be a process for creating and managing a territory that comprises of several municipalities and is endowed with specific identities. Local actors are accorded a key role in Pronat so that they can control their own futures. Territorial development favours local solidarity (between actors, including the most marginalized ones) and national cohesion (by combating spatial disparities). It also promotes a principle of integration and coherence between sectors, scales, dimensions of sustainable development, public policies and endogenous projects. Projects, proposed by very diverse actors with varied and often diverging interests, do not naturally converge at the territorial level. Territories are as much the expression of tensions, competitions and conflicts as of solidarity and cooperation (Sabourin, 2015). The need for coordination and arbitration is therefore paramount.

Territorial governance is the product of this coordination between actors with diverse objectives, resources and approaches, but who share a common project: the creation or consolidation of a territory (Rey-Valette *et al.*, 2014). This governance corresponds to a lower level of centralized territorial management, based on a partnership between public authorities, civil society and private operators. It is also a multi-level process that promotes vertical coordination, because it depends on decisions taken at other organizational levels, and itself influences others. Territorial governance traces its roots to decentralization, which is often linked to a withdrawal by the central State for financial reasons, and to the willingness of civil society to intervene in public affairs in greater measure. It increases the involvement of citizens in political action. Territorial governance takes the form of specific mechanisms which allow actors to translate a shared vision into common objectives, which are then broken down into projects, planning

tools and normative and financial frameworks. In Brazil, Pronat has promoted a unique mechanism for participatory governance, constituted by a territorial development college within the territories, as well as by councils at the state and federal levels.

CIRAD and its partners have supported this programme and participated in its national evaluation in collaboration with the Brazilian Ministry of Agrarian Development (MDA). The evaluation involved 26 universities in 37 rural territories. This rich experience has helped identify several challenges of territorial governance.

The power games around institutional participation and arrangements

Territorial governance must ensure the participation, mainly through representation, of the maximum number of actors in public decision-making. Pronat has thus encouraged actors who were hitherto excluded (mainly uneducated farmers, women and the young) to get involved in policy matters. It has also promoted agricultural development projects in rural areas that are less influenced by agribusiness and Green Revolution agriculture, both forms being generally unfavourable for family farming. Other roles of agriculture (food security for rural areas and small towns, employment, biodiversity management) have been recognized. The presence of the actors in debates, however, is not sufficient. It must be accompanied by transparent and efficient decision-making processes, which then implies that institutional arrangements, considered to be the 'rules of the game', and their conditions of use within the mechanisms, are of suitably good quality. The assessment of Pronat exposed problems, both in terms of mobilization (lack of presence of public bodies, weak legitimacy, and high participant turnover) and the fragility of decision-making rules and of the functioning of colleges (Piraux and Caniello, 2016). The groups of actors, including the ones in family farming, have organized themselves around interest groups, and therefore around power relations. However, conflicts that arise are rarely debated, thus resulting in blockages. The domination of certain groups or individuals and harmful political influences also hamper the quality of decisions. For example, within the Aguas Emendadas territory (DF-GO-MG), participation has mainly involved community leaders who have been representatives of agricultural communities for a long time. These prominent individuals have become professional negotiators and essential transactional leaders for the development and financing of collective rural development projects. Pronat also shows that frequent problem can arise in the relationship between farmers and elected officials, but solutions do exist. For example, an experiment carried out at the TASPP (Território do Alto Sertão Piauí e Pernambuco) showed that a long process of raising awareness of mayors led to the creation of an inter-municipal consortium where they are more active. The different partners have accepted alternative agricultural development projects that derive value from family farming, and are inspired by agroecology principles.

The assessment of Pronat has finally highlighted significant positive impacts, especially in terms of learning, including in the exercise of power, and improved relations between actors. As such, Polge (2015) has shown that territorial governance in the Amazonian territories of the State of Pará has led to a strengthening of local networks through local productive arrangements and, more broadly, organized proximities.

Need for innovation and support

Experience shows that the territorial leadership and engineering skills mobilized are key for the effective implementation or creation of the proposed governance mechanisms. They help in building up innovation capacities to promote coordination, encourage creativity and adapt to complex, uncertain and evolving situations. To this end, within the mechanisms, a common language (sense making) was developed and lessons were suggested to share knowledge (sense giving) and transfer tools and instruments (instrument-sizing) (Vitry and Chia, 2016). The solutions are then developed in experimental approaches to evaluate, test and fine-tune the processes depending on the situations – which are always unique. Local experiences highlight a significant need to support and institutionalize these experiments (Tonneau *et al.*, 2011).

Training initiatives contribute greatly to this process as they improve the representation frameworks and strengthen the organized proximities. At the TASPP territorial level, for example, a rural university, linked to the governance mechanism, has helped co-construct information, derive value from local knowledge and analyse complex situations to better inform debates, as regards credit, infrastructure and productive choices. Another training exercise in conflict management and understanding of territorial dynamics was conducted at the national level for participants in territorial colleges in charge of Pronat. It helped better prepare participants for the concertation necessary to create a mobilizing project to ascribe meaning to development actions.

The need for innovation also concerns institutions that are in charge of territorial development, often at more encompassing levels. This was the aim in assessing Pronat, but it showed the difficulties of undertaking such an exercise in a context of institutional inertia and routines.

Conclusion

The aim of territorial governance is to help regulate the interaction of public and private actors within territories and to ensure coherence between levels of organization. Experiments in Brazil have shown that territorial governance cannot be imposed. It must be created by the actors themselves according to situations that are always unique. Improving the capacity for innovation, translation and concertation thus represents an essential element in building relationships based on trust that are a prerequisite for effective governance.

But the processes remain very dependent on the balances of power and, more broadly, on policy frameworks. In Pronat in Brazil, the legitimacy of governance mechanisms was limited by a dependence on the federal administrative structure (constraints of bureaucratic procedures for disbursements and for project implementation), instability in local facilitation mechanisms, and a legal framework that makes them very dependent on the goodwill of mayors and federated States. Consolidating territorial governance therefore requires broader institutional innovations that can, in particular, guarantee greater autonomy for local mechanisms.

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Chapter 30

Forest concessions: a transition towards territorial development institutions?

Alain Karsenty

Concessions are a form of public-private partnership. States own or are assumed to own most natural forests. A State grants, for a period of a few years or decades, a right to exploit a resource (such as timber) while excluding, in general, rights over other resources. The more regions are landlocked and the lower the population density, the higher the number and extent of industrial concessions. Indeed, certain concessions in Central Africa exceed one million hectares in size. These concessionaires collect low volumes of timber per unit area due to high transport costs, which lead them to target only high-value timber. But the territories covered by these concessions are also home to local rights, such as hereditary rights over land, rights of access to hunting and fishing areas, and rights to collect non-timber products.

So far, territories have been managed through a specialization of spaces (land sparing), both in terms of production (agriculture *versus* forestry) and of status (industrial concessions *versus* community forests, protected areas). Demographic changes and local aspirations for real (and thus enforceable) land rights make the current forms of territorial sharing increasingly conflictual, which result in zero-sum games (one person's gain is another's loss). However, tropical forestry is an activity in which a combination of different activities can be envisaged in the same territory due to the highly selective nature of the exploitation (one or two trees removed per ha on an average) and rules of rotation that dictate that any operation can be carried out only once every 25-30 years on the same plot.

Territorial development institutions

Innovations from both private and public actors are making it possible to transform the role of forest concessions granted in territories. Over the last few years, initiatives have been launched with the support of NGOs for large-scale online mapping of

customary rights on lands and resources. Such is the case for the Mapping For Rights initiative[1], supported by the Rainforest Foundation, or the Rights and Resources Initiative (RRI)[2], which provides communities the opportunity to themselves affirm their presence in a given forest area, and allow decision-makers and private sector actors to become aware of and to recognize this presence. Industrial concessionaires have also helped change the traditional view of management of resources in separated spaces to meet social requirements of timber certification systems, especially of the Forest Stewardship Council (FSC), including the taking into account of local land rights. Some companies are systematically mapping customary rights (pertaining to the space occupied and 'legally' owned by a community, irrespective of the mode of appropriation, according to the definition of Henri Mendras) that overlap concession areas. Others prefer to limit themselves to demarcating the areas of influence of villages. These companies use such information to share a portion of the revenues derived from the exploitation of timber, on the basis of the extent of overlapping rights or simply on the basis of the existence of these areas. The amounts paid are managed by the company and the villagers have to form an association to benefit from the funds, which are intended for productive and social investments.

The mapping of rights and the revenue sharing associated with this cartography constitute the early stages of an evolution of concessions. A new generation of concessions driven not only by simple business rationales but also by the idea of taking care of overlapping tenure rights, would become institutions of territorial development. The extension of this territorial approach is reflected in the management of different layers of economic activity within the concession. For example, a safari operator in Congo has already been authorized to offer sport hunting activities in a forestry unit (concession) of several hundred thousand hectares allocated to a forestry company. This layer of the safari activity is therefore superimposed on the timber exploitation layer, and overall supervision has been entrusted to the forest concessionaire. Value can be derived from other resources, too. Non-timber products with high commercial value (such as okoumé resin in Gabon) or with a large domestic market could form the basis of chains combining processing and promotion in urban or export markets. Degraded areas could be restored and made productive by planting timber or perennial crops.

Existing forestry codes only authorize timber exploitation in forest concessions. Local populations are only allowed to exercise traditional usage rights and are forbidden to develop commercial activities with non-timber products. It will therefore be necessary to make legislative changes to allow concessionaires to start joint enterprises for the commercial exploitation of non-wood products with communities that are involved in the concession's management. These resources are already partly used by local populations within the concessions, and they constitute significant income sources that there is no question of denying to them. On the contrary, these activities need financial, technical and organizational support to increase their value addition. The presence of an industrial timber company can be an important asset in this context, provided that the institutional framework of the concession is modified to

1. http://map.mappingforrights.org/ (retrieved 19 April 2017).
2. http://www.rightsandresources.org/ (retrieved 19 April 2017).

allow concessionaires to extend their range of activities to other products as part of a co-managed process, which is itself supported by a sharing of the profits from the timber exploitation activity.

Combining the inclusive and the exclusive

These dynamics, if they are made thorough, organized and consistent within the framework of public policies, can serve as the starting point for a transformation of the concession system in Central Africa with the recognition of the rights associated with different institutional layers superimposed on the same territory. This can be

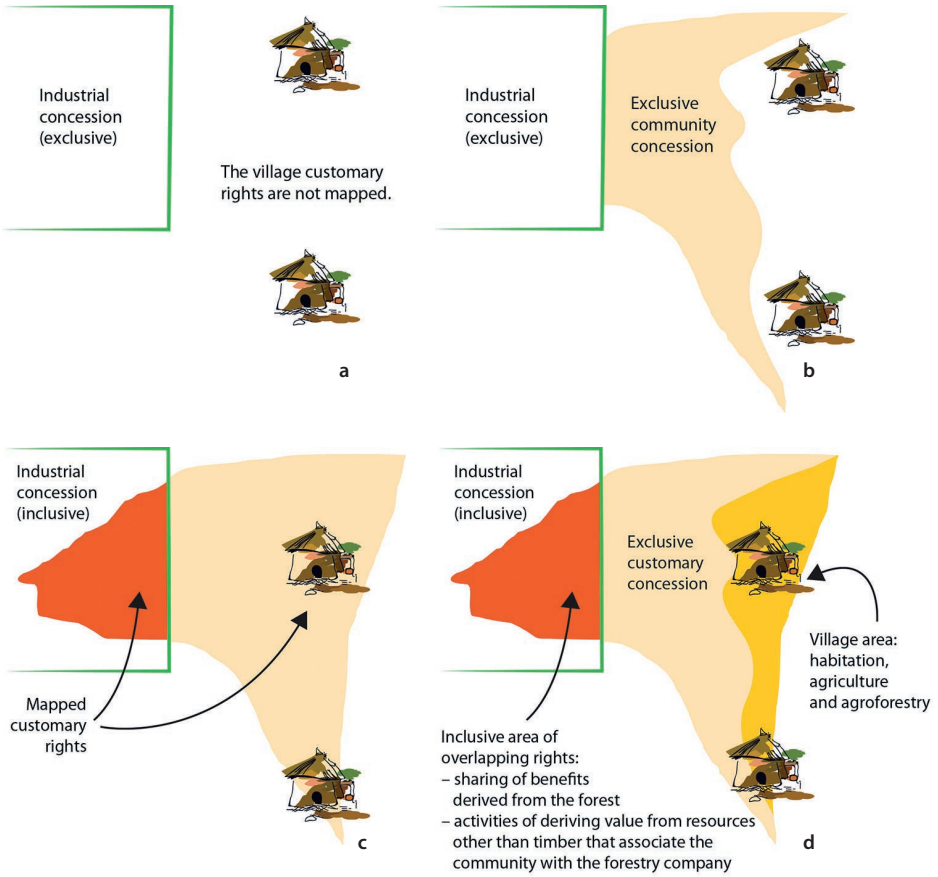

Figure 30.1. Different configurations of the territory based on a logic of specialization (land sparing) or a logic that combines specialization and superimposition (land sharing).

Situation 'a' is often the one that prevails, i.e., only industrial concessions (or protected areas) are recognized as territorial institutions, while the villages are known as mere areas of habitation and immediate influence.
Situation b: Community concessions can be established alongside industrial concessions in forested areas.
Situation c: Customary tenure rights are mapped using an approach that takes superimposition into account. Some of these rights overlap on the industrial concession and a new territorial reality emerges that consists of much more than a simple acknowledgement of the village presence.
Situation d: the inclusive and the exclusive are combined.
Source: Karsenty and Vermeulen (2016a).

called 'Concession 2.0'. Concession 2.0 can give rise to truly participatory governance schemes, based on joint economic activities, that include processes of shared decision-making through an institutionalized negotiation platform in which each partner would have a vote.

However, such a change in industrial concessions in terms of inclusive management should not be used to prevent local populations from securing exclusive spaces within their own community lands, such as community concessions which will allow them, in particular, to set up small timber enterprises. These entities, distinct from the inclusive space of Concession 2.0, reflect the aspiration of local communities to control their own territories, in which the actors are encouraged to cooperate socially and economically.

The most obvious obstacle is the lack of willingness and capacity of the industrial enterprise to promote such joint initiatives. Moreover, local social contexts are known to be unconducive to the establishment of economic structures that require the sustained cooperation of its members. However, this evolution of the concession to an institutional form of a new and inclusive territorial development may justify support from public development funds, support which is currently not forthcoming for industrial concessions due to the controversies surrounding them.

In many cases, substituting the specialization of spaces with various coordinated uses is the only feasible solution in a world where the pressure on resources is increasing in tandem with demographic density and the increasingly recognizable limits of natural capital. On the one hand, territories are criss-crossed by competing rights which specialization and the notion of absolute ownership are desperately trying to contain, with the risk of exacerbating conflicts of legitimacy. On the other hand, boundaries and demarcations have an essential role to play in providing security to vulnerable actors by enabling them to acquire enforceable rights, especially in these times of land grabbing.

Modern forms of land security must thus articulate the inclusive (manage the superimposition of rights) and the exclusive (ensure enforceable rights), in order to intelligently combine land sharing and land sparing in territorial development.

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Part 3

Tools, methods and incentives for territorial development

Chapter 31

The researcher and the territory: accompanying complexity

Hermine Papazian, Jérôme Queste, Pierre Bommel and François Bousquet

'The territory imposes itself as framework for coordination between multiple and fragmented actors in situations of asymmetry and with divergent interests' (Caron, Chapter 1). The challenge is that to achieve any useful coordination the uses and dynamics of natural and renewable resources have to be taken into account. This imperative leads many scientists to define their object of study in terms of a social and ecological system. Several different approaches exist for studying such an object, irrespective of whether it is a territory or a social and ecological system. For the past several decades, the complexity sciences, concerned with the states that emerge from interactions between heterogeneous entities, have provided a framework and tools to do so.

Complexity research undertaken between the 1950s and the 1980s showed the unpredictability of the future state of a system composed of interacting heterogeneous entities (Langton, 1992; Weisbuch, 1991). However, just because a system's future state cannot be calculated, it does not mean that the system will be in a state of disorder. Such a system will transition from a more or less stable organized state to another more or less stable organized state. The research therefore consists of understanding the phases of transition between these states. In the world of applied research on the relationships between nature and societies, various approaches have been gradually developed on the basis of these theoretical advances. An example is adaptive co-management (Armitage *et al.*, 2007), which proposes that the different stakeholders should together observe the trajectory of the system of which they are a part, identify when the transitions take place and decide what transitions are necessary when the system is in an undesirable state.

Initiated by CIRAD in the 1990s and applied since then by numerous teams on a wide variety of objects, the accompaniment approach proposes a process, a posture and tools to monitor the trajectory of a complex system (Barreteau *et al.*, 1997; Bousquet *et al.*, 1996; Collectif ComMod, 2005, 2006; Étienne, 2010). Apart from

a few cases of accompanying homogeneous groups[1], the general issue concerns the apprehension of the multiplicity and heterogeneity of groups of actors, and the interweaving of roles, mandates, responsibilities and rights in relationship with various interacting resources. By considering the territory as a complex system to which the accompaniment approach can be applied, we introduce some recent useful reflections. They pertain to the methodology, then to the posture of the accompanier, and, finally, to the effect of the process on the accompanier himself – three research issues that we suggest are relevant for general research on the territory.

A methodological proposal to accompany the regional co-management of a territory

The co-management of a territory requires the reconciliation of a horizontal cross-sectoral dialogue with a vertical participatory approach. The horizontal dialogue confronts the institutions, practices and interets whose proponents are the spokespersons of the various economic sectors. The vertical participatory approach confronts the points of views of the practitioners with those of the technicians and experts responsible for defining the 'good' practices and those of the policymakers in charge of forging formal institutions (Berkes, 2009). We use the Girovar case study to present the methodology to do so.

On Réunion island, the Integrated Organic Waste Management through Agricultural Enrichment on Réunion project (French acronym: Girovar, Chapter 21) was aimed at addressing an environmental issue: the management of organic waste in one of Réunion's four metropolises, a peri-urban territory of more than 180,000 inhabitants. The problem involved the divergences between the perceptions and expectations of the economic sectors, environmental ones (waste collection and treatment), agriculture, livestock husbandry and the agrifood industry.

The methodological choice was to compare intersectoral points of view, but to do so by involving different types of spokespersons within each sector (Queste, 2016). The participatory mechanism implemented was divided into three multi-actor arenas: practitioners in participatory workshops, technicians in technical group meetings, and institutional entities in steering committee meetings. Each arena was organized taking into account the constraints, habits and rituals of these three groups of actors: a multi-purpose hall in a rural area and an informal atmosphere for practitioners, a meeting room with IT facilities for technicians, a prestigious conference venue and the reading of speeches prepared in advance for the institutional entities.

Each of these three arenas was invited to work in sequence on a common prospective scenario, each one starting from the conclusions of the previous one. The common scenario then played the role of a frontier object (Carlile, 2002), i.e., allowing the translation, the transition from one arena to the other. The participation of facilitators in all the arenas also contributed to the convergence of proposals from the three arenas towards

1. There exists a frequent confusion between 'local scale' and 'homogeneity of the community'. Thus, it can happen that very diverse actors interact on multiple resources in a very small space, in the same way that very homogeneous groups can interact on a single resource over a very large space.

a common proposal that was, at the same time, institutionally legitimate, technically credible and relevant to the practitioners (Cash *et al.*, 2003). The scenarios produced in this way of co-management of organic matter have enabled this peri-urban territory to be accompanied in the process of resolving a green-waste crisis and to engage in territorialized recycling sectors for these materials, forming relationships between waste producers, processors and organic-fertilizer consumers (Wassenaar *et al.*, 2016).

Ethical choices in accompanying territorial transformations

We present a case study on an Amazonian territory, which serves as a basis for a reflection on the ethics of accompanying territories.

In the Amazonian floodplains (*varzeas*), inhabitants who traditionally used to make a living from agriculture and fishing have always coped with natural variations, between floods and dry seasons. However, climate change is now disrupting the frequencies and magnitudes of these floods, leading to great uncertainty for these populations, who realize how vulnerable they have become.

The ClimFabiam project (Bommel *et al.*, 2016) was initially designed to investigate how populations were experiencing current changes, how they were adapting their production systems, and what influence they could have on aquatic biodiversity. This project focused on the flooding of the Lago Grande de Curuaí, a territory of 30,000 inhabitants spread over 133 communities, which is part of Santarem prefecture (Pará State, Brazil). Hydrologically and biogeochemically, this territory is a good representation of the flood plains of the lower Amazon River where populations are isolated from the large cities of Pará and there is limited access to public services.

In this region, Incra, the National Institute of Settlement and Land Reform, is responsible for differentiating public lands from private ones, but due to lack of resources and the complexity of the task, land has been allocated without real demarcation and without public/private differentiation. Even though local people only have usage rights and hold no land titles, the sale of land is commonplace. Due to this legal grey area and after a long mobilization of the inhabitants, Incra finally created the 'Lago Grande do Curuaí' Agro-Extractivist Settlement Project (Portuguese abbreviation: PAE) in 2005. It is managed by the Federação Agroextrativista da Gleba Do Lago Grande (Feagle), a civil organization that institutionally represents this territory's communities. Feagle is in charge of monitoring agrarian reforms and the links between institutions, communities and social organizations. It also regulates natural resources by granting deforestation permits and hunting and fishing licenses. Today, this land registration project, designed to resolve conflicts over land and land uses, is only partially successful, as irregularities continue to be reported within the area. Moreover, its future remains uncertain. Indeed, regional conflicts and pressures from mining and timber extraction companies, as well as the complex land situation threaten its renewal and continued existence.

Given the vulnerability expressed by the actors, we first studied their concerns and strategies and then collectively discussed possible scenarios. To facilitate these debates

and make them more meaningful, a role-playing game and then a hybrid agent-based model (ABM) (allowing users to interact with the simulation) were designed progressively with producers and Feagle members.

The participatory approach forced us to revise the project's initial objectives in order to better respond to local concerns. Indeed, what emerged from lessons learned collectively from games and hybrid simulations was that the difficulties are not only due to climate change. Other changes, socio-economic and demographic, also play a part. For example, in these remote territories, population growth, due in part to the abandonment of *varzea* areas, has a significant impact on the environment. Without a sewage treatment system, this population growth is having an impact on water quality and leading to the proliferation of aquatic microorganisms. The project's biologists have shown an increased presence of cyanobacteria that pose a threat to human and animal health, as well as adverse effects on fish stocks already under pressure from commercial fishing and non-compliance with community fishing rules. Participants have often expressed the general feeling of not being heard on these issues by local authorities and institutions.

The question arises as to whether actors from outside the territory whose actions contribute significantly to the degradation of resources should be included. They include commercial fishing enterprises from Juruti or Óbidos, the *fazendeiros* (large-scale livestock breeders) of Óbidos, as well as major soya bean producers from Mato Grosso and bauxite mining companies who lobby local leaders to be allowed to buy land in the PAE. The issue of the participation of extra-territorial actors is not only methodological in nature, but also ethical. After all, we cannot blame these external actors for environmental degradation and not give them an opportunity to defend themselves through discussion and debate.

In the Amazonian context, far from the administrative centres of power, social violence is part of everyday life and extreme pressure is often exerted on the weak. Thus, by inviting external actors to participatory workshops and debates (assuming they were even willing to engage in this form of dialogue), we risked inciting more violence. In this particular context, the choice was made to initially bring together only the local actors in order to understand ongoing processes and to undertake a prospective approach. Accompanying the actors in establishing community rules aimed at guaranteeing their living conditions is already an ambitious task. By helping them to look forward over the medium term, the approach helps them to step back and understand the effects of each person's actions on the territory. Aware of the continuing deterioration, several actors have, for example, themselves proposed the strengthening of fishing rules and restrictions, or the adoption of collective forest management. In addition, by providing local institutions with scientific documentation on the state of natural resources and by contributing to social cohesion, the approach seeks to bolster the capacities of negotiation of these most vulnerable actors (Bommel *et al.*, 2016).

The accompanier too changes

After a methodological exposition, followed by an explication of the ethical posture of the researcher, we now address the reflexive dimension of the accompaniment approach. In its essence, the notion of accompaniment assumes that the various

participants will follow a trajectory that will transform them. The transformation of the scientist who accompanies territorial development is discussed here thanks to a doctoral research carried out in Senegal on the complex understanding of a pluralism of land regulation (Papazian, 2015).

A companion modelling methodology (Collectif ComMod, 2005), incorporating several methodological tools (individual interviews, role playing games, and multi-agent simulations) in a complementary way, was implemented to understand the expression of a regulatory pluralism at the scale of a Sahelian territory. The discovery and interactive use of these tools gradually changed the vision that the accompanier had of regulatory pluralism. This vision started by relying on a fixed explicative representation, result-oriented, based on surveys of the actors' land-related practices through questionnaires and interviews on Senegalese soil. It progressively evolved into a dynamic, process-oriented, comprehensive representation resulting from the complementary use of a role-playing game and multi-agent role simulations to help explain the dynamics of expression of a regulatory pluralism at the level of a Sahelian territory (see Box 31.1).

By meeting the Senegalese territory's actors through companion modelling, the representation of the pluralism of land regulation in this thesis work has been thus transformed. It has evolved from a superimposition of different land regulation systems, overlaid one on top of another, into a set of uncertain and flexible practices of actors, working interactively and dynamically in time and space. Such constructions allow the emergence of a pluralism of regulation at a territorial scale. Through the various experiments, of which one example is presented here, we observe that the accompaniment of a territory's actors contributes to a transformation of the vision of the scientist concerned. Beyond the fact that the scientist's point of view is seen only as one amongst others, his notion of the real, his own relationship with the other and with the world is called into question and transformed, during and at the end of the process of interaction with the diversity of the actors involved.

The posture adopted to accompany the actors of a territory

Territorial development is understood as the 'capacity of a territory's actors to control its future evolution' (Deffontaines *et al.*, 2001). The accompaniment approach was conceptualized, equipped and made operational many years ago so that researchers could engage with the actors for analyzing the complexity, exploring scenarios and seeking desirable futures. This involvement raises many questions and we have chosen to illustrate three of them in the light of three recent studies that deal with the methodology, ethical posture, and reflexive analysis of the scientist's transformations, without which the very notion of accompaniment would lose its meaning.

On the methodological level, these experiments show how multiple arenas and situations of action intervene during the process of accompaniment and contribute to territorial dynamics. In the experimental set-ups implemented, the co-constructed models have provided boundary objects, sufficiently flexible and polymorphic, to be

Box 31.1. Concept of regulatory pluralism.

The initial vision of regulatory pluralism analyzed in Papazian's (2015) doctoral research was derived from the concept introduced by the scientific world (Le Roy, 1996) to make sense of the jumble of the various Sahelian land regulation systems studied. This concept of pluralism is defined scientifically as a set of rules resulting from the juxtaposition of two modes of land regulation:
– local land systems, composed of sets of rights (*Ibid.*) that are complex, oral, collective and flexible in time and space, not officially recognized since independence in the 1960s by the governments of many Sahelian countries (Colin *et al.*, 2010);
– the land laws adopted by these same governments based on the generalization of individual and private ownership of rural land (Barrières, 2008), through a process of land registration.

This vision has gradually evolved during the course of the accompaniment approach towards a regulatory pluralism resulting from a dynamic and unpredictable process of interactions between individual perceptions that the different actors concerned with the land could have of their territory. If the human being is created with his temporality, he is also created with his spatiality, his personal vision of the space that he appropriates and on which he undertakes practices dynamically with emotions and feelings of ownership and identity (Barrières, 2008). For Sahelian users, the various land regulations that they perceive individually in the territory are, above all, responses to a need for land tenure security apprehended as a dynamic and changing feeling (Le Roy, 2011) according to the land context concerned. In this sense, the Senegalese users seem to have added the land policies successively put in place by Senegalese governments to their already existing – and not officially recognized – local regulatory systems. Regulatory pluralism is thus the product of a complex situation: actors secure their access to and use of land by mobilizing in a different way (Cleaver, 2002), depending on the local situation and the concerned land use, both the 'bank' of their local regulations as well as the different regulatory systems originating from land policies (both current legislation and officially obsolete legislation). They thus refer in their practices to different regulatory systems depending on the given situation.

apprehended by actors with different points of view of the territory under consideration but sufficiently robust to ensure this coherence. These models, however, have not been used autonomously, but as tools carried by the accompaniers, facilitating their role as transmitters of knowledge.

Faced with ethical questions about the commitment and social and political responsibility of the scientists involved in this type of approach, we call for a non-neutral posture on the part of researchers that promotes equity and sustainability, because we consider unavoidable the power games that take place within a territory (d'Aquino, 2002), and we consciously choose to contribute to building up the capacities of the most vulnerable actors. If we ignore asymmetries of power, we risk reinforcing these inequalities by allowing the more powerful to influence the outcomes of the participatory process more in their favour (Barnaud and Van Paassen, 2013). In stark contrast

to a neutral scientific posture, our vision of accompaniment aims to protect the most vulnerable, who also tend to be those most affected by any changes. This choice is also justified by the fact that territorial development requires the strengthening of capacities of collective action. Anything less would lead to irreversible situations, going against the very notion of sustainable and fair development.

Accompanying reflections and actions on the interactions between people, societies and resources, from a perspective of sustainable development, through the prism of a complex understanding, requires understanding no doubt, but also self-understanding and understanding of the other (Morin, 2004). For an accompanier, understanding complexity begins by becoming aware of one's own frames of reference and the paradigm from which one thinks and acts. Only then will the accompanier be able to understand the modes of reflection of others and build, over time, an exchange that transforms all the actors involved in this accompaniment.

The companion modelling approach was created to treat the management of renewable natural resources as the management of a complex system. This form of collective action, driven by its methodological and ethical choices, culminates in a set of transformations – including that of the scientist himself – that contributes to territorial development.

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Chapter 32

Assessing the capacity of cropping systems to respond to challenges of sustainable territorial development

Mathieu Vigne, Angel Avadí, Michael S. Corson, Jonathan Vayssières and Tom Wassenaar

While agricultural activities can contribute to territorial development through the use and management of space, or by participating in local cohesion, identity and economic activities, they can also affect development negatively. This happens most often with the intensification of productive processes, resulting in a decoupling of short-term production objectives from long-term environmental and social ones. In the case of anthropized ecosystems, these contributions refer to the notions of ecosystem services and dis-services[1] (Karsenty *et al.*, 2009). They can also be compared to the economic concept of externalities[2], even though this concept is limited to effects that are not commercially traded.

Nevertheless, the assessment of these contributions, necessary for promoting the sustainable development of a territory, is complex. First, because these contributions are numerous, interrelated and sometimes difficult to quantify. Second, because the sustainable development of a territory is the result of compromises between different dimensions of sustainability that not only necessitate interdisciplinary approaches, but also normative frameworks whose relevance can be called into question. And finally, because the very concept of territory, as the sphere of influence of production systems interacting with different ecosystems and resources, is difficult to establish (Chapter 1). Furthermore, territories are currently considered differently when evaluating these contributions. The first modality consists of considering the territory as a level of organization in which the agricultural systems to be assessed are situated. The second considers the territory as a space of interaction between agricultural

1. Material and non-material benefits (services) or losses (dis-services) derived from ecosystems in their natural state or modified by human practices.
2. Defined here as the effects the activities of a person or company have on other activities. Externalities can harm or benefit others – in other words, they can be negative or positive.

activities, other activities, and the ecosystems on which they are based. The territory becomes the subject of the assessment. These two approaches not only substantially influence the methods that are used, but also the application of the results to support the sustainable development of territories.

The territory as a level of organization

In an assessment, the territory is often considered as a level of organization of agricultural activities. The object of the study is then limited to production systems, to the supply chain, or even to the entire agricultural sector, without exhaustively considering other actors of the territory. The ecological footprint[3] of the system under study is not necessarily restricted to the territory in which it is situated.

Thus, in addition to the direct access to locally produced food, agricultural activities also promote economic access to food through income generation. In several territories, livestock husbandry in particular is one of the few economic opportunities for the most deprived, such as the landless and the nomadic populations, and is a factor of social integration in areas where youth unemployment is high. For example, by using the ALive LSIPT tool (Box 32.1), Alary *et al.* (2011) show that, in the Sahelian zone of Mali, livestock activities contribute to more than 45% of the income in the households studied, even for those that are more oriented towards agriculture in the strictest sense. Agricultural activities also play a catalyzing role for other sectors of activity in the territory. In particular, they promote job creation through the establishment of supply chains and associated support services. The agrifood sector as a whole (collectors, wholesalers, transporters, processors, suppliers of inputs, distributors, restaurant owners) is thus one of the most promising in terms of job creation for young people with low or medium levels of qualification (Bricas and Broutin, 2006). In Benin, for example, a 1999 employment census indicated that the agrifood sector accounted for 41% of national employment. In a better referenced context, such as that of Réunion Island, it was shown, using the method of assessing effects, that a poultry farmer contributed directly and indirectly to maintaining the equivalent of approximately 15 minimum-wage (SMIC) earners in Réunion and two in metropolitan France (Thévenot, 2014).

From an environmental point of view, various processes induced by agriculture, such as the extraction of raw materials or the elimination of excess nutrients into different biophysical compartments of the territories (water, soil, air) can negatively affect their sustainability through processes such as eutrophication, acidification, increased toxicity, or changes at a more global scale (climate change). It therefore appears necessary to identify and quantify these risks, and to propose scenarios capable of reducing these impacts. For example, the carbon (C) balance helps identify the emission and sequestration potentials of grazed pasture ecosystems. Its application in an arid environment in the service area of a borewell located in Widou, in the north of Senegal, has shown a negative greenhouse gas balance (-0.01 T CO_2-eq/ha/yr) for the study area (Assouma *et al.*, 2014). In wetlands, this balance, estimated by the Carpagg project on 30-year-old Guyanese grasslands, could be as high as -1.2 ± 0.5 T CO_2-eq/ha/year (Blanfort

3. The ecological footprint (Wackernagel and Rees, 1996) is defined here as the ecosystems and populations impacted by the agricultural activities being assessed.

et al., 2014). The nutrient balance helps determine potential losses to the various environmental compartments of the territory, as well as associated pollution risks. An approach based on the quantification of biomass flows at the level of production systems, and the analysis of their nitrogen (N) content makes it possible, for example, to analyze the efficiencies of N utilisation in the various compartments of the system. Its application in Madagascar (Alvarez *et al.*, 2014), Senegal (Audouin *et al.*, 2015) and Burkina Faso (Diarisso *et al.*, 2015) have shown that the rates and locations of N losses differ according to contexts and production systems.

However, these assessments offer only a limited view of the potential contributions of production systems to their local environment. A life cycle assessment using statistical models could account for the consumption of resources and emissions associated

Box 32.1. The Livestock-Poverty Toolkit (LSIPT).

Céline Dutilly and Mathieu Vigne

In the early 2000s, some international organizations believed that many countries in sub-Saharan Africa had not paid enough attention to the livestock sector's potential for reducing poverty and supporting economic growth (Blench *et al.*, 2003). As a result, a toolkit for investment and policy development in the livestock sector (Livestock-Poverty guide, LSIPT Livestock Sector Investment and Policy Toolkit) was developed as part of the ALive Partnership for Livestock Development, poverty alleviation and sustainable growth in Africa (www.alive-online.org). Its design was entrusted to a group of research and development institutions: CIRAD, IIED, FAO PPLPI (Pro-Poor Livestock Policy Initiative), World Bank, etc.

The proposed process involves three principal phases:
– a preparatory phase to identify and collate a robust and coherent set of data and information on the sector;
– a technical, financial and socio-economic diagnosis phase based on quantitative data and modelling at the three livestock activity levels: micro-economics (livestock systems and households), meso-economic (analysis of the chains) and macro-economic (contribution to GDP and food security);
– a phase of assessing funding and investment opportunities in the sector by developing investment plans based on solid data and presenting a case for investment. This activity follows the logic and process of CAADP (http://www.caadp.net), which supports investment plans promoted by countries in the agricultural sector, with the outcomes and recommendations prepared by the actors for presentation to entities such as finance ministries, planning ministries, international agencies, donors and the private sector.

The diagnostic phase and the assessment tools for the sector were proposed by CIRAD (Alary *et al.*, 2014). The revenue-based approach makes it possible to estimate incomes, both direct as well as indirect (animal traction and use of fertilizer by the agricultural sector), monetary and non-monetary (self-consumption, bartering) of all livestock farming activities from the level of the herd to that of the national economy. LSIPT has been implemented in Mali, Zambia, Ethiopia and, recently, in Tanzania.

with a production system or product throughout its life cycle (Jolliet *et al.*, 2010). It is thus an improvement in the representation of potential impacts or damage. A review of life cycle assessments applied to perennial crops (Bessou *et al.*, 2013) has shown that, in most production chains, the cropping system appears to be the main contributor to global warming, eutrophication and potential impacts of toxicity. Reducing the environmental impact of agricultural production therefore mainly comes down to focusing on territories where cropping systems are located. On Réunion Island, the life cycle assessment of the poultry chain, whose main links are located within the same territory, showed a variable contribution of production systems to environmental impacts induced by the chain (Thévenot, 2014). Consequently, although these production systems are responsible for much of the eutrophication risk from soils used in the chain, directly in Réunion and indirectly in other territories (mainly for food production), they are little involved in the direct emission of greenhouse gases resulting from the chain's activities.

The assessment of livestock husbandry shows that its social contributions appear to be limited in comparison to economic and environmental approaches. Nevertheless, the latter are known. In contrast, even though the social, cultural and symbolic dimensions of livestock have been well highlighted (HLPE, 2016), their quantification is complex. Among the methods proposed to do so, the analysis of social impacts during the life cycle (called 'social LCA') could be interesting (Macombe *et al.*, 2013), but it is still not widely undertaken. It explores, for example, the effects of income inequalities on the health of local populations (Feschet *et al.*, 2013) or on health risks associated with agricultural activities (Di Cesare *et al.*, 2016). Consequently, such a method also focuses on the territory, both for its scale as well as an object of study. It would be all the more useful if, combined with other analytical frameworks, it could be used for a multi-criteria assessment allowing a comprehensive analysis of the multiple contributions of livestock systems to the sustainability of their territories, since such analyses are often qualitative at the moment (Vall *et al.*, 2016). In Benin, for example, the IDEA method[4] was used to assess the sustainability of market gardening production (Ahouangninou *et al.*, 2015). This method proposes a comprehensive approach to the sustainability of agricultural production systems through self-assessment. To this end, it incorporates agroecological, socio-territorial and economic dimensions in order to assess the strengths and weaknesses of the system using quantified indicators, and to identify ways of improving sustainability. The socio-territorial sustainability assessed in the method refers to ethics and human development (Vilain *et al.*, 2008). It characterizes, on the basis of the farmer's quality of life and the amount of market or non-market services, the integration of the farm in the territory to which it belongs and in society.

Life cycle assessment for territorial development

Although life cycle assessments have often been carried out at higher levels, they have traditionally been centred on the plot, farm and production system, to complement models that are primarily dynamic. They thus open the door to the optimal

4. http://www.idea.chlorofil.fr (retrieved 30 March 2017).

use of energy and the looping of carbon and nutrients cycles across several farms to conserve natural resources while optimizing production. The so-called 'territorial' analysis of environmental impacts over the life cycle can thus take into account exchanges between farms (e.g., manure and fodder), landscape management (e.g., distribution of agricultural activities) and centralized activities (e.g., the treatment of livestock effluents). Various approaches have been applied to estimate pollution emission flows and environmental impacts of all agricultural production at the level of a territory such as a watershed (Moreau *et al.*, 2013; Avadí *et al.*, 2016). The spatialized territorial approach, which integrates dynamic models, is all the more interesting as it allows a better consideration of the influence of spatial and temporal variability on emissions and of the environmental impacts of a territory (Nitschelm *et al.*, 2016).

However, taking into account all production systems and processes is onerous. Recent approaches have thus attempted to describe the environmental performance of a territory's agricultural sector by extrapolating life cycle assessments of farms using statistical or model-based methods (Box 32.2). For example, in order to assess the environmental impacts of an irrigated territory in Tunisia, Pradeleix *et al.* (2012) proposed the 'diagnosis of agrarian systems' as an approach adapted to situations lacking reliable statistical data. This approach culminates in the modelling of different production systems by taking into account the diversity of actual farming practices. Unlike statistical approaches, it establishes clear causal relationships within the framework of the functioning of each type of agricultural system identified. It also considers the complexity of the territory, from the global to the particular, and analyzes agricultural activities at different scales.

The territorial life cycle assessment presents modelling challenges, in addition to those normally expected from conventional agricultural life cycle assessments (Caffrey and Veal, 2013), such as the representation of the agricultural sector on the basis of a few farms. At present, it is necessary to have a statistically representative sample of farms in the territory for generalizations to make sense. The recourse to a typology of farms, ideally based on biophysical factors, seems relevant because a life cycle assessment is essentially a framework for biophysical accounting. However, this approach is still being developed, since the aggregation of individual farms and the taking into account of the inherent variability remain unsolved, and since life cycle assessments have traditionally focused on systems at smaller scales. A comprehensive assessment of a territory's activities or, at the very minimum, of all those that interact with agricultural activities, is also a significant challenge. Loiseau *et al.* (2013) thus propose a life cycle assessment framework adapted to a territory's environmental assessment, i.e., to all of its activities of production and consumption. Applied to the Bassin de Thau, a lagoon in southern France, it has permitted the determination of the relative role of agriculture in the environmental balance in the territory in relation to other production and consumption activities (Loiseau *et al.*, 2014). This approach could therefore be relevant for the territory's sustainable development by providing the environmental assessment of various planning scenarios. However, it requires significant amounts of data and a detailed knowledge of the interactions between activities.

Box 32.2. Territorial life cycle assessment for an *ex ante* evaluation of the environmental consequences of implementing agricultural strategies in two territories in Brittany.

Angel Avadí and Michael Corson

The goal of the European CANtogether FP7 project is to design, assess and promote new agricultural systems and practices linking livestock production and cropping systems at the farm and regional level in an effort to optimize energy, carbon and nutrients flows. Territorial life cycle assessments for this project were carried out for three case studies: the intervention areas of a cooperative (Coopédom) and a watershed area in Brittany (Lieue de Grève) in France and a mountainous area with low and high altitudes in Switzerland (Thurgau and Grisons cantons).

An approach used in this project for Lieue de Grève (Avadí *et al.*, 2016) and Coopédom was to establish an initial categorization of farms in the territory through a hierarchical grouping of major components. Subsequently, a life cycle assessment was carried out for each farm, and the impacts of each farm category (per hectare or per kg of agricultural product) were calculated from different farms in the category, either as an average of the impacts or by using linear regressions between structural characteristics and estimated impacts obtained from the life cycle assessment. The sum total of the territory's impacts (for its total agricultural area or its total production of an agricultural product) was calculated as the sum of impacts of different farm categories. This approach was used to predict the effect on regional environmental impacts due to the implementation of certain agricultural management strategies, such as extensification or intensification of dairy production, by complementing and validating the results of the dynamic models* used in the same territory.

For example, when applying the approach to an innovation scenario involving dairy and mixed (milch and meat breeds) farms in Lieue de Grève (average stock density reduced from 2.7 to 1.4 large cattle unit/ha of grassland, number of milch cows increased by 15% to maintain milk production from each farm, increased grassland area, and maize silage reduced accordingly, to provide the necessary fodder mass for the largest herd, and surface area of all other crops reduced to maintain the UAA of each farm), the results estimated a reduction in the regional eutrophication (-11%) in the same order of magnitude as predicted by modelling N at the level of the watershed (-26%) (Moreau *et al.*, 2013). The eutrophication potential was reduced by 15% per tonne of milk. Potential impacts decreased from 5 to 54% per hectare per tonne of milk in all other impact categories, due to a reduced intake of concentrated feed and fertilizers. In the regional context, where eutrophication is a major concern, there is a need to reduce the impact of eutrophication per hectare.

*The life cycle assessment accounts for, in association with static models, the consumption of resources by and emissions associated with a production system or a product, over its entire life cycle (Jolliet *et al.*, 2010).

The territory as a subject for assessment

While the farm has long been considered the most appropriate level for decision-making and strategic management in agriculture (Del Prado *et al.*, 2013), there is a growing interest in policy assessment and agricultural management strategies at

the territorial level (Payraudeau and van der Werf, 2005). This interest is illustrated by the emergence of approaches in which the territory is considered a subject for study in its own right. In these approaches, it is considered a socio-economic system whose economic and social activities are based on local ecosystems. The agricultural sector is thus considered as one of the components of the territory.

Territorial ecology, an emerging discipline, is interested for example in the flows of materials and energy between the different components of a territory (Barles, 2014). In this way, it highlights the catalytic role of certain agricultural activities in the territories (Wassenaar, 2015). Territorial ecology uses methods such as the modelling of materials and energy flows, and the analysis of substance flows.

The studies carried out by CIRAD show that livestock husbandry plays a major role in these dynamics. A study in the groundnut production basin of Senegal focused on measuring the incoming, outgoing and circulating biomass flows between different components of three interconnected systems: the terroir, the household and the plot. These flows concerned the main products of the tree layer, crops (grains, residues, etc.), livestock (organic manure, animals, milk, etc.) as well as the main inputs (mineral fertilizers, concentrated feed, foodstuffs, etc.). The study focused on two villages with different trajectories (Audouin *et al.*, 2015): Diohine, where collective resources managed by the organization of a common fallow highlighted inter-household interactions; and Barry Sine, where a more individual and more intensive resource management system resulted in the emergence of sheep fattening and the maintenance of commercial groundnut cultivation. In spite of a greater productivity at the terroir level for Barry Sine, animal herds played a major role in the organization of the N cycle in both villages, accounting for 60 to 80% of N flows.

Finally, in a rural sub-prefecture typical of the savannahs of West Africa (Koumbia, Burkina Faso), a study first aimed at estimating the total biomass productivity of the territory based on the mapping of the sub-prefecture and the typology of the different agroecological environments. The use of this biomass for different human activities and its exchange between activities were then estimated (Blanchard *et al.*, 2015). The results showed that despite the low percentage of biomass consumed directly by animals (11%), the latter account for more than a quarter of the biomass exchanged in the territory, thus actually promoting integration between agriculture and livestock husbandry.

However, the role of crops in these biomass flows cannot be overlooked. In particular, they offer the means for deriving value, through organic fertilization, from non-agricultural resources available in the territory. In Réunion, for example, the Girovar project identified three scenarios corresponding to three types of fertilizer products, which were relevant to the needs of Réunion's agriculture, and were made from organic waste products of agricultural and non-agricultural origins available. Co-constructing such scenarios and verifying their performance requires tools to represent flows within a territory (see Chapter 33). In addition, these scenarios are able to provide information to several assessments for testing their sustainability. Thus, while socio-economic viability and acceptability are criteria that are explicitly and universally considered in the development process, the same is not true for the environmental dimension. Dumoulin *et al.* (2016) have recently proposed a framework that helps, as pertinently

as possible, keep such a process informed (with reference to the perception of the actors concerned and the biophysical characteristics of the territory in question) about the gamut of environmental consequences that could result from the envisaged development. This is, however, not an off-the-shelf tool; it requires the deduction and rigorous construction of a set of *ad hoc* indicators, each of which must be estimated by a specific method.

Without claiming to be exclusive, these approaches to territorial ecology call for combining various tools such as systemic modelling (e.g., multi-agents), life cycle assessments, biophysical models or exposure models. Such integrated approaches provide a dynamic and more holistic view of the impact of the evolution of systems and the agricultural sector on the other components of the territory, and consequently on territorial development.

Conclusion

The assessment of the contribution of production systems to the sustainability of territorial development seems to be still incomplete. It is especially affected by a methodological failure and a lack of coherence between different approaches for an overall assessment of this contribution. Few approaches have so far proposed taking into account the wide range of environmental, economic and social impacts associated with activities in a territory. The methodological immaturity of certain approaches, which is partly due to their recent emergence, is also a factor. However, past and current initiatives show a strong dynamism, mainly linked to the interest in assessing sustainability at levels such as the territorial. It seems therefore essential to support this interest, especially to find solutions to some conceptual and methodological problems of changes in scale that are still unresolved.

The question of the relevance of the additivity of environmental impacts is still rarely addressed. The extrapolation of individual externalities specific to each system at higher scales is too often treated as the oversimple sum of these individual externalities. Furthermore, territorialized indicators that take into account trade-offs between the different systems must be developed. Finally, an understanding of territorial dynamics is indispensable for accompanying agricultural systems along trajectories that favour their own sustainability, while encouraging their contribution, through their positive externalities, to the sustainability of overall territorial development. Indeed, subjected to different influences, the agricultural activities evolve together with territories. Using the example of the reconfiguration of seven dairy farming basins, Napoléone *et al.* (2015) threw light on their evolutions through the interlinked development of livestock systems, territories and sectors on which they depend. However, understanding these territorial dynamics requires a complex set of data, in terms of the temporal dimension, as well as the number of actors, levels of organization and processes involved. It is therefore a question of being able to set up, in conjunction with local stakeholders, observatories for agricultural territories (see Chapter 37), especially in the countries of the Global South, where there are few long-term monitoring systems, and where the collection and storage of information is poorly structured (Vall *et al.*, 2016).

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Chapter 33

Monitoring territorial dynamics by remote sensing and spatial modelling

Camille Jahel, Louise Leroux, Émile Faye, Karen Colin de Verdière, Pascal Degenne, Danny Lo Seen and Xavier Augusseau

The territory, defined as a geographical space as appropriated and perceived by individual or collective actors, evolves in space and time under the effects of natural and anthropogenic factors in an institutional, political and social context. It is therefore inherently dynamic. Planning and decision-making for territories consequently require a detailed knowledge and an objective representation of ongoing, expected or planned processes at different spatio-temporal levels of analysis.

This chapter provides an overview of tools for monitoring and modelling territorial dynamics. Without claiming to provide a turn-key solution to analyzing and understanding the spatial and temporal dynamics of territories, these tools can nonetheless be used as aids for decision-making for spatial planning. Remote sensing can help describe and quantify territorial dynamics, and spatial modelling can provide us a detailed understanding of the complex spatio-temporal processes underpinning these dynamics.

Description and quantification of territorial dynamics by remote sensing

Use of remote sensing to characterize the organization of territories

In its broadest definition, remote sensing is described as the set of techniques and knowledge used to determine physiological and biological characteristics of objects using measurements made without direct contact with them. Thus, when applied to the Earth, remote sensing provides direct or indirect indicators on various biophysical parameters (e.g. leaf area indices, soil moisture indices, phenological metrics) to characterize the functioning of features on the Earth's surface. Due to their systematic and synoptic nature and their temporal repetitiveness, remote sensing data helps us

expand our understanding of past and present dynamics at work on the territories. Their cost is constantly decreasing, thanks to an ever-growing supply of more and more useful images (satellite, aerial, etc.) and to the increase in the number of free or paid platforms for processing this data (e.g., eCognition Developer, ENVI, QGIS). The diversity of the available images generates a multiplicity of objects to be studied, ranging from the cultivated plot, through the use of new technologies like drones (Box 33.1), to the village terroir, with high or very high spatial resolution satellite imagery (in the order of 1 metre) such as from Pleiades or SPOT, to the level of the watershed with medium spatial resolution imagery (in the order of 100 metres) like MODIS or SPOT VGT. Different temporalities of change can also be assessed, allowing for seasonal or inter-annual monitoring of ecosystems.

In the countries of the Global South, for which cartographic and geographic information is generally lacking, remote sensing data is an important source of information to describe the organization of territories and measure their dynamics in regions that are sometimes difficult to access. For example, it is possible to map the forests in the Congo Basin (covering over 3 million km^2, i.e. five times the area of France) using satellites, whereas it would be difficult, if not impossible, to undertake a comprehensive mapping on the ground, with no road access within the forests (Box 33.2).

Box 33.1. Drones as tools for territorial development.

Émile Faye

Since they became available for civilian use, drones – remote-controlled, unmanned aerial vehicles – have become essential tools in several spheres (risk prevention, inspection of infrastructure, agriculture, environment, research, audiovisual disciplines). As noted by Watts *et al.* in 2012, drones today represent a real technological revolution for acquiring scientific data, especially in domains where *in situ* measurements are difficult using traditional means, or for which satellites and planes do not offer the same flexibility of use, or a sufficient spatial and temporal resolution. In fact, flying slowly at low altitudes, drones equipped with different sensors (visible, near infrared, thermal infrared and laser cameras, Figure 33.1A) can collect very high spatial resolution geo-localized images (of the order of cm^2/pixel). These images provide precise multi-spectral maps and digital terrain models for surface areas of several tens of hectares per flight. However, the steep learning curve, the limitations in processing the large amounts of acquired data, and increasingly strict regulatory constraints are hampering the adoption of these new tools.

Thus, CIRAD researchers, using these tools, have focused on identifying and characterizing agronomic, ecological and sociological processes at spatio-temporal scales and resolutions appropriate for studying territorial dynamics. Working at scales ranging from the plot to the agroecosystem as a whole, they study the effects of functional diversity of landscapes (composition and spatial configuration of agroecosystems) on yields and ecosystem services for pest control and plant pollination (at resolutions suited for observing insects). They use remote sensing tools on these high-resolution images to understand and model water stress and plant health (Figure 33.1B) in order to adapt irrigation and quantities of inputs to individual plants.

Finally, they analyze the dynamics of a village territory by comparing time series of land use maps obtained through drones (reduction of forest areas due to agriculture and urbanization). Drones are thus useful tools for describing, mapping, quantifying, understanding and modelling the functioning of agroecosystems at spatio-temporal resolutions relevant to the study of territories.

Figure 33.1. A. A hexacopter equipped with a camera and a thermal camera. B. A hyper-resolution mapping of the surface temperature of the canopy, only of sweet potatoes.

Using remote sensing to reconstruct territorial dynamics

Two broad types of analyses are generally carried out using remote sensing depending on the spatial scale under consideration: analysis of crop production trends at the regional scale (continental or sub-regional) and the analysis of changes in land use at a more local level (village terroir, watershed).

Based on vegetation index time series of type NOAA-AVHRR (10-day period and a spatial resolution of 8 km) or MODIS (bi-monthly, and a spatial resolution of 250 m), vegetation production trend analyses help identify statistically changes in the photosynthetic activity of plant covers and to make an initial diagnosis of the territories's functioning. These trends can then be interpreted in terms of improved vegetation production or vegetation degradation – but without any indication on the cause of these changes. For example, while satellite observation showed a general tendency of a recovery of Sahelian vegetation following the increase in rainfall over the past 30 years (e.g., Fensholt *et al.*, 2013), recent studies have, however, shown a tendency of plant cover degradation that could be the result of non-climate factors, either natural or anthropogenic (Box 33.3). Brandt *et al.* (2016) have, for example, recently highlighted a trend towards degradation of ligneous resources in the Baban Rafi forest in Niger and in the Zamfara reserve in Nigeria, which, according to the authors, is due to the selective felling of tree species and of the allocation of an excessive amount of newly cleared land to agriculture.

The main trends in vegetation are therefore the result of complex processes, combining both global and local factors. Analyses at the local scale, mainly concerning the characterization of changes in land use (or socio-economic land use), are therefore a key step in describing territorial dynamics. This involves a diachronic analysis of land use

Box 33.2. Satellite imagery for monitoring forest areas.

Karen Colin de Verdière

There is a very limited use of remote sensing technologies in the countries of the Global South because of the paucity of satellite data and the inadequate capacity to interpret and use them. At the Copenhagen summit in December 2009, the French Development Agency, in partnership with Airbus Defence and Space (a provider of satellite images), undertook to provide high-resolution SPOT satellite images, free of charge, to governments, research institutes and civil society organizations working for sustainable forest management in the Congo Basin. This initiative has helped boost the use of spatial data in Central Africa, strengthen the capacity of local actors to use these technologies and encourage the creation of national forest maps for an improved assessment of the effectiveness of anti-deforestation policies. Building on these results and achievements, a new project was launched in 2015, extending these benefits to three countries in West Africa (Guinea, Benin and Côte d'Ivoire). Its aim is to study past and present land-use dynamics and land-use changes in the savannah and degraded forest territories, using recent and historical high-resolution satellite imagery.

The Geoforafri project, funded by the French Facility for Global Environment (FFEM), is simultaneously promoting the adoption and the methodological and technical mastery of Earth observation satellite data in Central and West African countries by building capacity and user networks for these technologies.

In general, these interventions in an always-evolving high-technology domain require a significant public commitment to build image generation infrastructure that can be used by public and private actors, and robust systems to verify the interpretations. Training of national experts and their association with international networks is therefore essential.

(Based on Desclée *et al.*, 2014)

maps of a territory obtained from high spatial resolution satellite archives such as Landsat. At this scale of analysis, it then becomes possible to identify the part played by anthropogenic pressures in the dynamics observed. By analyzing land use changes between 1960 and 2010 around major African cities, Brinkmann *et al.* (2012) have, for example, highlighted an urban sprawl accompanied by an increase in cultivated area at the expense of forests. Thus, while remote sensing helps identify and describe areas with strong dynamics, it offers little information on the processes behind these changes whose detailed understanding is, nonetheless, essential for land use planning or for implementing resource management in these areas undergoing change. The use of spatial modelling then becomes necessary for an in-depth study of these processes.

Modelling territorial dynamics

Principles of models of territorial dynamics

The monitoring and assessment of territorial dynamics reveal changes resulting from ongoing, multiple and complex processes that researchers seek to understand and describe for better-informed decision-making. In this approach, modelling is

often used as a methodology to formalize existing knowledge on the territory into a simplified description but one that is adequate to address a particular question. When models are built with computer tools, it is possible to carry out virtual experiments on these territories, such as testing hypotheses considered relevant for certain processes, or comparing and assessing different development scenarios of a territory according to previously defined criteria.

Box 33.3. Trends of and factors behind recent developments in plant biomass production in the Sahel: what satellite imagery tells us.

Louise Leroux

Which areas in the Sahel are undergoing a decline in crop production? In what way is the climate responsible for the observed dynamics? With looming climatic and demographic changes, these are some of the questions that must be answered in order to identify populations that are at risk and to propose ways of adapting to these changes. After processing information from time series on vegetation and climate, Leroux *et al.* (2016) have shown that there has been a tendency in some areas, such as the south-west of Niger, over the last 15 years, of a degradation of vegetation production, i.e., a potential reduction in agricultural and fodder production. The authors also showed that climate was definitely not the sole factor behind the observed degradation. By combining initial analyses carried out at a regional scale with local environmental, demographic and economic data, they highlight, map and quantify the degradation of the laterite plateaus with tiger bush around the city of Niamey (Niger). This degradation is mainly due to the overexploitation of timber resources to meet the city's increasing demand for fuel wood resulting from the increasing urbanization in West Africa (e.g., Brinkmann *et al.*, 2012; Leblanc *et al.*, 2008).

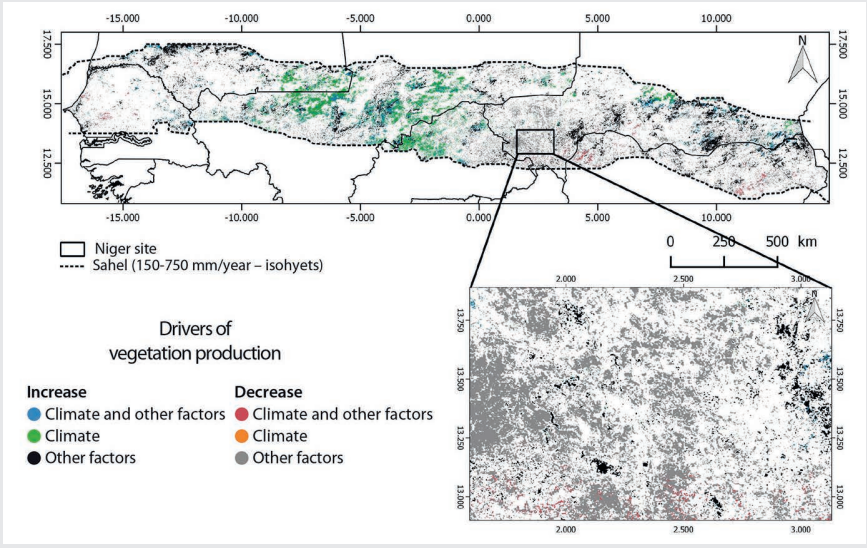

Figure 33.2 What are the factors behind the trends in plant biomass production in the Sahel?
Source: Leroux *et al.*, 2016.

However, constructing such models, i.e., modelling the processes behind territorial dynamics remains not only a technological challenge, but also a conceptual and methodological one. Processes are often dynamic and spatially distributed, interact at different spatial and temporal scales, and include human activities. Several disciplines are usually involved, including the geographical and agricultural sciences, economics, social sciences, mathematics, and computer sciences, which makes modelling a means to integrate these disciplines (Schmidt-Lainé and Pavé, 2002). Although the lack of an integrative framework is keenly felt (Gaucherel *et al.*, 2014), scientific communities have started working together on Land-Change Science for studies on sustainability and on changes in the global environment (Rindfuss *et al.*, 2004).

Several modelling approaches have contributed to in-depth studies of territorial dynamics. Those that include the largest user communities are systems dynamics, cellular automata and multi-agent systems. In the systems dynamics approach (Forrester, 1968), processes are represented in the form of stocks (system variables), flows (exchanges between stocks) and feedback loops (where the result of an action is involved in steering the action). Thus, in the Spatial Modelling Environment (SME; Costanza and Voinov, 2004), space is divided into cells, each containing a stock-flow model, with the possibility of organizing or directing flows between neighbouring cells. In cellular automata, the geographical space is also divided into cells, each of which can be in a finite number of states. The state of each cell changes according to transition rules which take into account the states of neighbouring cells. This approach is mainly used in the study of urban dynamics (for example, Batty and Xie, 1994; Dubos-Paillard *et al.*, 2003). Multi-agent systems and cellular automata are centred on individuals. They originate from the concept of the agent, capable of communicating and reacting to an event, extended to the concept of agent, who has objectives to be achieved and can make decisions autonomously. They evolve in an environment they perceive, and on which they can act and draw resources from. Bousquet and Le Page (2004) explain the current state of the art of this approach applied to the management of ecosystems.

These approaches are now widely used to deal with territorial dynamics, but the inherent spatial dimension is not usually represented in a detailed manner. If it was, it would become difficult to process.

Taking interactions within the territory into account: the example of Ocelet

Systems dynamics modelling is often adapted to categories of problems for which we have an overall understanding of the exchanges in the system. The individual-based approaches are more suitable when the individual behaviours of a system's elements can be described, and the aim is to study the emergent properties resulting from these behaviours. The study of territorial dynamics requires the integration of knowledge from different disciplines, and it is often necessary to reconcile the local vision with the global vision.

One way of proceeding, which has not been implemented in the modelling families mentioned above, is to base the reflection on the interactions as common denominators.

The 'territory' system is then seen as a set of interacting entities sharing a part of the space, the evolution of the system being the result of these interactions. This entire process can be formalized using interaction graphs (a graph is a mathematical object consisting of nodes, with edges connecting these nodes): the nodes represent the territory's components and the edges represent the interaction functions (Box 33.4). A single concept serves to represent spatial, social, hierarchical or functional relationships. This facilitates not only the integration of points of view from different disciplines in the construction of territorial dynamics models, but also the simultaneous consideration of the different scales in which these interactions are to be considered.

This interaction graphs-based approach has been implemented in the Ocelet spatial modelling language (Degenne and Lo Seen, 2016) and the associated simulation platform, which stands out in this way from other modelling families. The concept of the interaction graph is central to this language, which is equipped with the tools required to import, export and process various types of geographical data. We thus have the means for including spatial relations with the other forms of relationships needed to simulate territorial dynamics.

The first experiment of modelling territorial dynamics, based on Ocelet and the interaction graph concept, was carried out in an island context on Réunion Island (Lestrelin *et al.*, 2017) where land is scarce and its availability an important issue, especially in peri-urban areas. Several models of land use dynamics were created to help characterize different scenarios of territorial dynamics using landscape simulation. Initially, these models integrated urban dynamics processes (urban planning, densification, social housing, and the appearance of urban sprawl) constrained by housing and infrastructure needs. They mainly generated indicators on the consumption of agricultural land. Agricultural dynamics processes (farm cycles, reconversion of wastelands, water supply for irrigated land, diversification) were added in the second phase. Cartographic outputs have highlighted the contrast between production areas that are especially vulnerable to urban pressure and those that remain stable in most scenarios. These models were most notably used to illustrate the possible interactions between different public policies. Boxes 33.4 and 33.5 illustrate the use of the Ocelet platform in very different case studies.

Box 33.4. Spatial modelling of runoff in the Saint-Gilles ravine watershed on Réunion Island.

Pascal Degenne

The French strategy for the integrated management of the sea and coastal areas in the southern Indian Ocean region resulted in an initiative by the West Coast Territories community to carry out a trial of such a strategy on its territory (Degenne et al., 2015). The many issues and subjects identified by the actors participating in the project (water resources, biodiversity, fisheries, agriculture, land, etc.) have been linked to processes (erosion, agricultural dynamics, irrigation, development of recreational activities, waste disposal into the sea, etc.), and these links have shown at what point the whole becomes a system. Some processes that were clearly seen to be integrators

were modelled. For example, runoff is the link between land use, maintenance of ravines, various types of pollution, coastal flooding risk, and water quality in the lagoon and in the marine reserve.

Two complementary models were developed to simulate runoff. The first, by the Geosciences laboratory of the University of Réunion, was based on the HMS (Hydrological Modelling System) software application and relied on a spatial division of the watershed into seven sub-basins. In line with current knowledge, it successfully categorized, in order of magnitude, the hydrological characteristics of the watershed and its ravines.

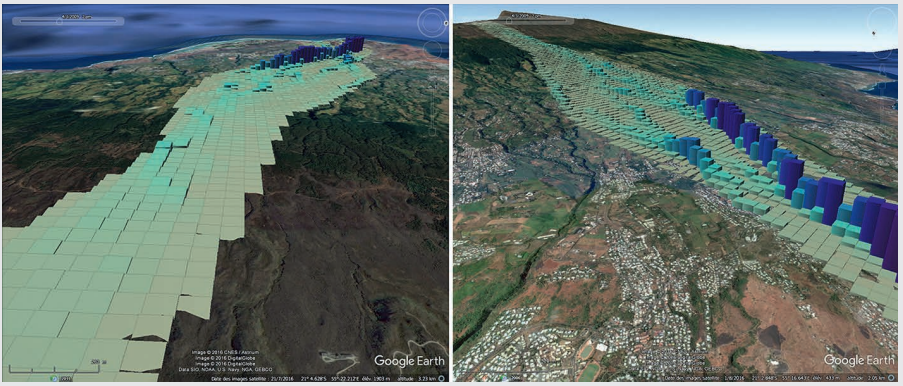

Figure 33.3. Example of dynamic maps derived from the simulation of the model based on Ocelet during a rain event.

Animated cartographic rendering of the simulation of runoff in the Saint-Gilles ravine during a rain event. The colour and height of the cells are proportional to the flow calculated at each point.

The second component of this modelling work was created by CIRAD, and is based on the Ocelet language. This model is finely spatialized and allows the attribution of properties (rate of runoff, infiltration, sub-soil reservoir, drainage rate) individually to each cell of the selected section. The rendering of the simulations as dynamic mapping helped in characterizing the territory for the actors during workshops. This second model was also intended to be linked with models dealing with other subjects (flooding, land use dynamics) designed with Ocelet in the same territory, especially for testing highly localized measures envisaged to enhance infiltration.

Box 33.5. Spatial modelling of an agroecosystem's dynamics: case of the cotton production basin of western Burkina Faso.

Camille Jahel

Already undermined by significant intra- and inter-annual climate variability, the cotton production basin of western Burkina Faso has undergone a profound and rapid change over the past 15 years, due in particular to intense demographic pressure and to the implementation of development policies that favour export crops. Changes are visible at the landscape level: maize-cotton rotation has replaced the

earlier cropping systems based mainly on cereals and legumes, and the landscape is close to saturation with a gradual conversion of the remaining dry forests into cultivation and a drastic reduction in the fallow period of the plots. Recent studies carried by Jahel *et al.* (2016) use the Ocelet approach to analyze the processes at different scales at the origin of this agrarian system's dynamics and to compare their respective influences in the changes recorded.

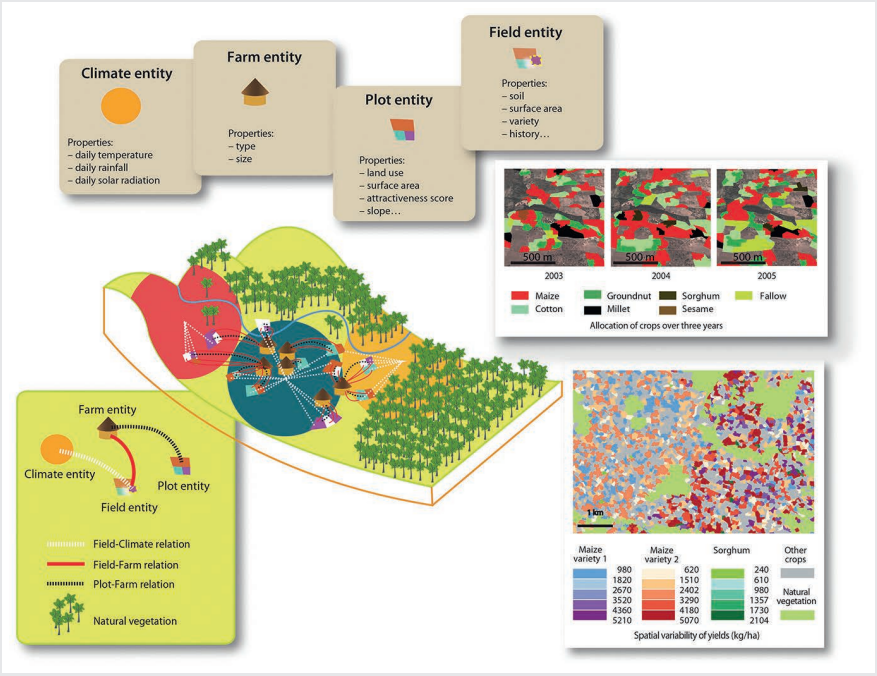

Figure 33.4. Schematic representation of the model's structure, modelled entities and examples of simulation outputs.

Adapted from Jahel *et al.* (2016).

Three main processes were modelled for the Tuy province (about 6000 km²): extension of the cultivated area at the provincial level, crop rotation at the farm level, and cereal production at the level of the cultivated field. The evolution of the cultivated area is modelled every year and takes into account changes in farm size, the creation or disappearance of farms, natural population growth and migration. The annual crop rotation takes into account farmers' strategies in the context of their farms, which includes, in particular, the market price of cereals, cash crops and the relationship with the cotton sector. The SARRA-H crop model (Baron *et al.*, 2003) is used to model the daily cereal production for each locally characterized field using rainfall and climate data. The model was then used to assess quantitatively:

– the impact of the farmers' strategy to geographically disperse their plots to minimize climate risks;
– the importance of fallowing in a landscape where arable land is becoming scarce;
– the consequences of the farmers' limited access to credit to purchase fertilizers.

Conclusion

Remote sensing and spatial modelling are two complementary tools for analyzing and monitoring territorial dynamics at several scales. From drones to medium spatial resolution satellites, remote sensing offers many possibilities to characterize and measure territorial dynamics over a wide area and in an objective way, especially in areas with difficult access or where little data is available. The challenge then is to understand and analyze the observed and measured dynamics, which necessarily requires incorporating additional information from different disciplines (geography, agronomy, sociology, etc.). Modelling serves to link the dynamics observed and the different knowledge of the processes at work in the territory, by translating this knowledge into spatial rules that allow the reproduction, and thus the explanation, of the dynamics observed.

The combined use of these two tools then allows for retro-prospective and prospective analyses of the territorial dynamics at work, which are essential to incorporate into any territorial planning. However, while these spatial approaches contribute to improving the existing knowledge of, and studies on, territorial dynamics, they represent only one of the keys to understanding territories.

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Chapter 34

Territorial observatories: a tool for development?

Jean Philippe Tonneau, Philippe Lemoisson, Magalie Jannoyer, Pierre Maurel, Philippe Cattan, Marianne Le Bail and Vincent Bonnal

Observatories: new tools for the production of finalized knowledge

The word 'observatory' originally refers to a mechanism for understanding and predicting a physical phenomenon (Piron, 1996). In recent decades, in a rapidly changing world of uncertainty and over-information, States and local authorities have set up observatories to compensate for 'a marked deficiency in knowledge or expertise'[1]. Observatories are also seen as new forms of knowledge production through a renewed relationship between research and action.

Among the numerous existing observatories (on prices, secularism, public tranquillity, etc.), some support territorial development with the aim of reshaping public action and addressing major societal challenges (see Chapter 1). Such observatories have proliferated in recent years, both in the countries of the North and the South, and multiple functions have been assigned to them. They include knowledge production; capacity building; aid for decision-making and action; collection and organization of data and information; organization of communities for research, reflection, debate or action around a shared project; communication; etc.

The goal entrusted to territorial observatories makes their implementation difficult. CIRAD has proposed an original approach to accompany this implementation. This approach forms the basis of this chapter. We introduce it by describing the notion of the territorial observatory and defining its specificities. These specificities justify a process of co-construction of tools that can help to observe a territory and steer collective action. We chose two observatories to describe these tools: one in the French West Indies and the other in the Bassin de Thau, a lagoon in southern France. These two situations are put in perspective to draw some lessons.

1. Jospin L., 1996. Response to questions from the French Senate. http://www.senat.fr/questions/base/1996/qSEQ960515509.html

Territorial observatories: specificities and requirements

We distinguish the notion of 'territorial observatory' from that of 'observatory of the territory'. An observatory of the territory organizes and makes available information on the territory (maps, databases, indicators, monographs, statistics, studies, surveys, etc.), most often through a website or a data portal with mapping functionalities. An observatory of the territory is thus primarily a means for disseminating data, information and tools to various audiences (Académie des sciences, 2006). These mechanisms are not designed to address specific issues. Territorial observatories, on the other hand, are specifically built around a socio-technical response to a given issue, which could be as diverse as urban growth, water pollution, youth unemployment, etc.

A territorial observatory is thus always organized around three characteristics: the explicit and shared identification of a priority issue for the territory, the active presence of a community of actors and decision-makers gathered around this issue and the will to build a permanent information system dedicated to this issue. Territorial observatories are thus diverse according to the nature and scope of the issues they are dealing with, the extent of territories and their modes of governance, and the size and composition of the communities involved. However, features common to various situations can be identified.

First of all, a territorial observatory is always created at the initiative of a sponsor, a funding entity, a politician, a scientist, a group of citizens or an institution. An 'observatory' dynamic, resulting from analyses of ground reality, exchanges and debates, allows a community to explore an issue identified as a priority by producing appropriate knowledge for the public good. This dynamic is based on a social and organizational dimension that brings together the community of actors around a common effort to address the issue concerned.

A second dimension of the observatory is technical. It allows the management, preparation, organization, formatting, sharing, analysis and discussion of data, information and knowledge in order to monitor the development of the territory that is facing the problem in question. It takes the form of a multi-partner and horizontal information system, i.e., a mechanism in which the actors are both data providers and users of decision-making information.

On the basis of these common features, CIRAD has developed a method called CoObs (Lemoisson and Passouant, 2012) to accompany the design and implementation of territorial observatories. After introducing the co-construction process that forms the basis of this approach, we will provide details of some methodological tools.

Introduction to a co-construction process

Let us recall the triptych that constitutes an observatory: an issue, a community and an information system. To summarize, the implementation of a territorial observatory amounts to defining a project around an issue, forming a community for reflection and action, and building a long-term technical observation mechanism.

The selection of the issue is always the result of an overall diagnosis of the territory. This diagnosis provides an outline of the situation and describes the territory and its dynamics. It identifies a diversity of issues and justifies the selection of a high priority issue by the community of actors involved in the diagnosis. The choice is, of course, not neutral, but the continuous analysis of the issue allows a fine-tuning of the choice as the work progresses.

The actor community involved in an observatory project does not necessarily meet the definition of Brown *et al.* (1989), for whom the community denotes a group of people sharing the same values and points of view. In our view, collectively appropriating a territorial issue means to be aware of the opportunity of a gain or a loss for the territory. This does not necessarily imply identical values, similar visions of the territory, or even similar objectives. Indeed, the exercise of co-construction of the observatory is difficult because it requires taking into account perceptions of actors with diverse and sometimes conflicting interests, who are engaged in some kind of 'obligatory communication' (Duran and Thoenig, 1996). Moreover, the constitution of the community encounters the well-known problems of participatory representativeness. How to prevent the issue from being appropriated by a group for its own benefit? In Brazil, for example (Chapter 29), the quality of the implemented territorial engineering allowed the inclusion of the 'voiceless'.

In addition to the collective consciousness of an issue, a territorial observatory presupposes awareness of a strong link between the strategic component ('What has to be done?'), the operational component ('How to do it?') and the informational component ('What information is required for action?') (de Sède Marceau *et al.*, 2011). The production of information supports the implementation of an action that was chosen to address the issue. It is a matter of establishing, in a collective process in which observations are shared, an observation-action-observation cycle. Sharing observations thus leads to transforming measurements into information, i.e., to ensure that the data collected makes sense to all the actors.

In the CoObs approach, actions are identified by sharing individual understandings of territorial dynamics. This collaborative work of representing the dynamics at play (model of territorial dynamics) leads to a prioritization of the actions to be carried out (action model), as well as to the definition of the tools for steering these actions (observation model).

The quality of the co-construction process of the models determines the success of the observatory project, since it represents the opportunity to create a common culture in collective learning situations. The process of co-creating the tools for reflecting on and steering the development of their territory gives the actors space for negotiating their individual objectives in the face of a common issue.

CIRAD and its partners have recently implemented this approach in several locations, most notably in the Bassin de Thau (Lemoisson *et al.*, 2016) and the French West Indies (Cattan *et al.*, 2014), presented below, as well as in Senegal and Brazil (Tonneau *et al.*, 2011).

Tools to reflect on and steer development

In this section, we first present the 'territorial dynamics model' and illustrate its importance for a project in the French West Indies. We then present the action model and the observation model, and illustrate them using the example of the Bassin de Thau where the technology associated with the territorial observatory is being used.

The territorial dynamics model: the example of an observatory centred on the 'water quality' issue in the French West Indies

At the very beginning of the initial stages of the co-construction process, the territorial dynamics model establishes the basis of a common understanding, and confers coherence to observation and action. The community of field actors, institutional partners and scientists refine the initial diagnosis that helped select the high-priority issue, while paying special attention to cause and effect relationships. On the basis of relatively formalized elements of analysis, three types of variables are identified and linked: the territorial constraints (or drivers) forwhich it is not possible to take significant measures during the project (e.g., climate change, demographic structure, international regulations, etc.); the variables describing the state of the territory in terms of its social, economic and environmental aspects (e.g., land use, water quality, etc.); and action variables describing practices and transformations that have an impact on the territory (e.g., irrigation, use of inputs, creation of a protected area, etc.).

In order to illustrate this step, let us look more closely at an issue that has, of late, become a priority in the French West Indies: water quality. Because the tropical humid climate favours bioaggressors (pests, diseases and weeds), horticultural agrosystems regularly use pesticides. In the case of the Galion river watershed in Martinique, the quality of watercourses has been seriously degraded by such agricultural pollution. Researchers have been monitoring this phenomenon for over 15 years. Good practices (active ingredients, doses, frequency of treatments) have been laid down and are being applied by farmers on their plots. This, however, does not translate into compliance with current environmental standards[2] for groundwater and river water contamination (Raimbault, 2014). An explanation is that a large amount of sub-surface water flow discharges into watercourses (Mottes *et al.*, 2015; Charlier, 2007). The polluted plots in a watershed generally affect the quality of all water that flows through it (Della Rossa *et al.*, 2014).

This diagnosis calls for the management of water and soil quality at the territorial level of the watershed, i.e., for the collective management of cultivation strategies, for which we know how to calculate the phytosanitary pressure (Houdard, 2005). This is the reason why different actors (producers, technical advisers, water-quality managers, territorial managers, politicians, researchers) came together to set up an observatory to help organize and monitor the territorial management of crop strategies to reduce the use of pesticides (Cattan *et al.*, 2014).

2. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for the Community action in the field of water policy. *Official Journal* no. L 327 of 22/12/2000 p. 0001 – 0073; http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1489508220310&uri=CELEX:32000L0060

The development of the territorial dynamics model will lead, in particular, to consolidating the analysis of the relationships between the practices and the measured impacts, taking into account all the complexity of the pesticide transfer processes, in terms of temporality and heterogeneity. In addition to this analysis, by bringing together actors of the watershed, the observatory could enable the implementation and assessment of innovations capable of providing sustainable solutions.

The action model and the observation model: the example of the Bassin de Thau observatory centred on the issue of 'land use'

At the end of the co-construction of the territorial dynamics model, the participating actors identify regulatory and corrective actions, and organize them into an action plan. At the same time, they outline their requirements for information to steer these actions. It is the set of actions decided on the basis of the territorial dynamics model, associated with an initial specification of their monitoring, that constitutes the model of action.

The model of action raises a question about information: 'What information is needed to steer and assess collective action in order to address the issue?' This entails specifying, in a comprehensive manner, indicators for long-term monitoring of the state of the territory and the actions, as well as the constraints that weigh on the territory. Also, it is necessary to define the information services that will provide adequate information to each category of actors to steer their objectives. These two elements are closely linked because information services derive their information from the system of indicators and present them as thematic maps, dashboards, numerical charts, etc. Together, they constitute the observation model.

The design phase of the observatory is complete once the two models have been defined. What remains is to design and execute the technical mechanism, the basis for information management, and to assist actors in implementing it. Following a period of operating the observatory, the actors assess the relevance of the planned actions, check if the model of the dynamics is robust, and propose possible changes to the models. The CoObs approach is iterative, as shown in Figure 34.1.

To illustrate the interweaving between the models of action and observation, we take the specific case of a 'land use' issue in the Bassin de Thau territory, in southern France. This territory is characterized by great biodiversity, a large variety of landscapes and a multiplicity of economic activities: fishing, viticulture, hydrotherapy, tourism and recreational activities. The territory is under severe demographic pressures and is witnessing a growing urban sprawl. These dynamics are not only impacting the equilibrium of the environmental system, but also generating tensions between activities as well as social inequalities arising from the sharp rise in prices of built-up land. Climate change is also affecting this territory with coastline erosion and the risk of marine submersion. The Joint Association for the Bassin de Thau, which has coordinated the lagoon's management since 2006, has adopted the CoObs approach to develop its information system. In this case, the action model already existed at the beginning of the collaboration, in the form of a Coherent Territorial Planning Scheme (French acronym: SCoT) supported by its action plan. Correspondingly, an impressive system of several hundred indicators had already been specified, some of

which were regularly supported by measurements and statistics. Work pertaining to the iterative CoObs approach began directly with the observation model, notably on the definition of information services to steer SCoT actions (Lemoisson *et al.*, 2016).

Figure 34.2 illustrates an online multimodal information service for viewing the indicators. The image was obtained from a screenshot of the online platform, which was in its test phase at the time of writing. The service produces a set of indicators to gauge population pressures, urban sprawl and the instability of the environmental system. A set of alternate representation options (maps, diagrams, numeric charts, diachronic diagrams, etc.), which is linked to this generic nucleus and to a geographic layer management system, provides each category of users with the desired information in the form most useful to them.

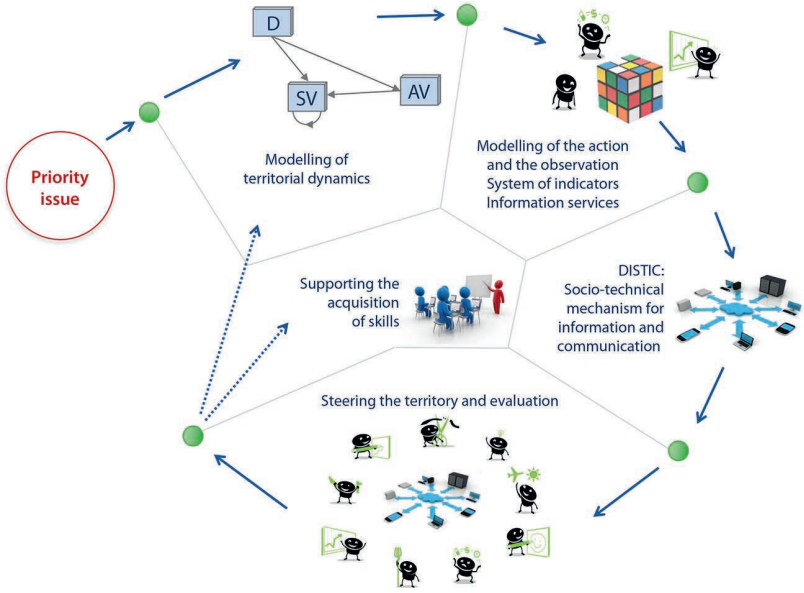

Figure 34.1. The construction of an observatory based on the CoObs approach.

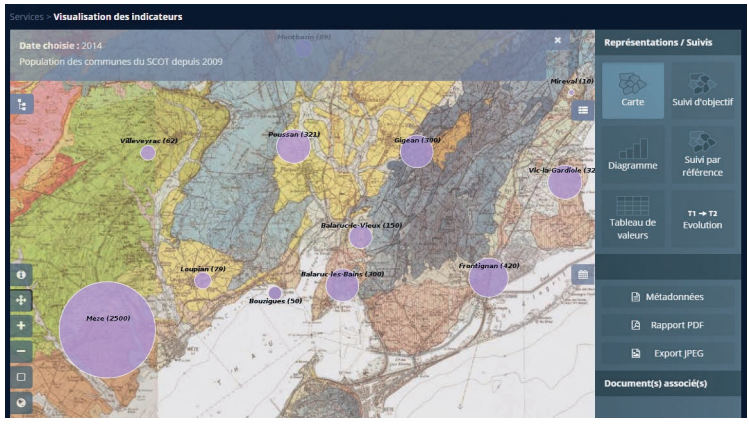

Figure 34.2. Multimodal information service for displaying indicators.

In conclusion

Under the term 'territorial observatory', we have presented mechanisms in which a high-priority territorial issue is clearly identified, and a community of actors is actively addressing it, with the aim of building a permanent sustainable information system to monitor it. We presented the main points of a co-construction process, where the work on models precedes a socio-technical mechanism dedicated to the management of the action, illustrating them with two experiments at different stages of advancement.

It is too early to claim complete feedback on this approach as the observatories mentioned have not been evaluated yet. A first lesson to be learned concerns the 'time of collective action'. The process of designing, implementing and institutionalizing a territorial observatory is drawn out and takes place over several years.

The first experiment (observatory of water quality in the French West Indies) has reached its initial milestones. The presentation of the approach and the preliminary work have attracted a great deal of interest from the actors, but this does not necessarily mean they will have a lasting motivation to continue. Nevertheless, the need for tools to monitor the development of the territories is real, and the interest in collective learning through co-construction seems to encourage fruitful collaboration for the next steps.

The observatory of land use in the Bassin de Thau is an institutional observatory (since it is implemented by a territorial public organization of the lagoon) in a rapidly developing territory. It is at the deployment stage of the technical mechanism. The quality and efficiency of the technical mechanism, which must meet the needs of the partners, are essential here. Although it is too early to assess its relevance in supporting territorial development, the presentation of the technical mechanism to other territorial managers, notably in the Pays de Gâtine, has led to the idea of creating a 'user/contributor club' of the platform originally designed for the Bassin de Thau. It is a matter of joint investment on a software tool to handle any system of indicators. The partners of this club would then considerably shorten the time of the design-development cycle associated with the CoObs method. This would allow them to dedicate their energies entirely on the social and organizational mechanism that is at the heart of the territorial observatories. The whole approach will become more responsive to the emergence of new development challenges.

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Chapter 35

Requirements, instruments and mechanisms of funding of rural territories

Vatché Papazian and Mathilde Gasperi

The definition given to the territory and the common theme adopted in this book have helped: identify available resources from which value can be derived; consider land as the determining factor to access resources and use them; characterize the institutional and social actors[1] operating in rural areas; identify their modalities of coordination, regulation and governance; and present innovative analytical methods and tools. Some chapters have in particular reported on actions of territorial development involving the decisions and responsibilities of different types of actors: local authorities, municipalities, producer organizations and associations. Irrespective of the nature of these actions[2] and the territorial scale they apply to (family farms, lineage-based territories, municipal territories, regional spaces, delimited spaces, watersheds, natural parks, irrigated perimeters), the question of their funding – by the actors themselves, by financial operators or the State – remains crucial. We shall consider here two instances of funding of activities and investments in rural territories, which have been the object of numerous interventions by development agencies and operators in Africa: credit for farming activities, mainly focused on funding agricultural campaigns, and the funding and taxation of rural territorial communities.

Funding requirements of agriculture and financial offers

The funding requirements of family farming, contractual/agro-industrial agriculture and, more generally, of the various rural actors can be divided into short-term needs (funding for the growing season, inputs, seeds, farming practices, seasonal transition, marketing), and medium- and long-term investments for individual use (equipment, farm mechanization, plantations, facilities, equipment for pumping,

1. State technical services, devolved or decentralized public institutions and entities, local authorities, municipalities, socio-professional organizations, service providers, NGOs, civil society, etc.
2. Production activities, production or service infrastructure for collective use, pastoral facilities, forests, water/irrigation facilities and infrastructure, rural roads, transhumance corridors, vaccination camps, markets, slaughterhouses, dairies, drying units, warehouses, etc.

irrigation, livestock husbandry and transportation) or collective use (equipment and infrastructure for post-harvest operations, collection, transportation, storage, packaging, processing, marketing).

Since the 1980s, States have formulated national agricultural credit policies to address these diverse funding needs, facilitate access to them, and ensure their availability to actors in rural territories. To do so, they have set up public development banks and provided interest rate subsidies to agriculture. These policies and the agricultural credit agencies have met with varied outcomes.[3] While Senegal and Mali have managed to continue subsidizing interest rates for agricultural credit and to support agricultural credit institutions, in most countries, agriculture no longer benefits from special funding conditions. Farmers now obtain financial services from a significant number of financial operators linked to agricultural development/credit banks (where they exist), such as mutual savings and credit networks, decentralized financial systems, cooperative credit mechanisms, and microfinance institutions. Moreover, some commercial banks have set up deconcentrated/decentralized networks for territories that primarily target emerging economic actors[4] in production chains and SMEs in rural areas who can provide sufficient guarantees (service providers, traders, processors, transport operators, rice specialists, etc.). Finally, financial initiatives by the States, such as the Priority Investment Guarantee Fund (FONGIP) of Senegal, or regional institutions, such as the Central Bank of West African States (BCEAO) or the West African Development Bank (BOAD), support agricultural policies and initiatives of member States. In particular, they encourage commercial banks to reach out and move closer to private entrepreneurs and small- and medium-sized enterprises.

What does this multidimensional credit offer encompass? The availability of short-term credit for producer groups (village associations, farmer groups or producer/irrigator groups, economic interest groups, cooperatives), which is most often based on a mutual guarantee principle and is managed by the beneficiary group, helps support agricultural production activity (annual campaigns, inputs, small-scale mechanization) but suffers from instability given the possibility of the undermining of the mutual guarantee because of repayment failures, crises or internal organizational issues. At the same time, credit for equipment granted to individuals as part of State-sponsored efforts to promote mechanization (tractors, threshers, agricultural equipment, mini rice mills, etc.) or directly by banks, have always been limited/constrained by the lack of real guarantees from the majority of beneficiaries. Starting in the 1990s, decentralized financial systems (Kafo Jiginew in the Malian cotton zones, Crédit mutuel in Senegal, mutual assistance funds) gradually introduced individualized accounts and loans for marketing activities secured by innovative guarantee mechanisms (warrantage, collateral management). On the other hand, the question of guaranteeing loans for equipment or long-term investments (earmarked for development, planting,

3. Thirty years on, of the dozen or so development banks created, only two (BNDA of Mali and CNCAS of Senegal) continue to retain their agricultural specificity in their operations. Others have been privatized and operate as commercial banks (CNCA of Burkina Faso), while some (Togo, Côte d'Ivoire) have disappeared altogether from the banking landscape.

4. See profiles/trajectories of the 'small emerging players' of the Senegal River delta (d'Aquino and Seck, 2014).

mechanization, irrigation) remains unresolved, leaving potential demand unmet. In the agricultural domain, hydro-agricultural facilities (for example, in the Senegal River valley or the Office du Niger in Mali) or perennial plantations (rubber in particular) are among the few operations where bank participation is available and supported, to ensure, through loans and suitable guarantees, that the farmers' contributive share to long-term investments is covered.

Public and privatized companies involved in developing and regulating agro-industrial chains (cotton, groundnuts, rice, perennial crops) have often incorporated mechanisms to provide necessary credit to producers (seeds, inputs, crop protection products, seed drills, small equipment[5]) by deducting repayment amounts at the time of purchasing the produce. These direct contractual relations with producers, without intervention from banks, are based on professional relationships between the purchasing companies and the supplying farmers, with the real indicator of the contracting process being the price paid to the producer. It is therefore on this basis that producers in these integrated sectors have moved to organize themselves into associations, cooperatives, unions or federations and have set up interprofessional organizations (groundnut, cotton) to negotiate/co-manage mechanisms for fixing and stabilizing prices, based on global price fluctuations. AFD has largely supported this movement by establishing stabilization funds, especially in the cotton sector in Mali, Senegal and Burkina Faso, whose tripartite management by the State, the cotton company and farmers' representation based on an agreed set of rules has helped avoid the adverse effects of price fluctuations on African agriculture.

Agro-industrial companies responsible for the collection, processing and marketing of agricultural production have direct access to and use banks (banking pool, agricultural credit) both to finance their purchasing/marketing campaigns and for their long-term investments (cotton ginning units, oil mills, transport equipment, infrastructure). In addition to providing support in the area of agricultural credit, the State helps fund infrastructure that falls under its ambit, thus providing an environment that is conducive for the development of the chains.

The funding of individual or collective/municipal investments by rural territorial communities

However, the involvement of financial operators (banks, decentralized financial systems, microfinance) remains strictly limited to the requirements and actors of agricultural chains. The funding of activities and investments carried out at deconcentrated territorial administration levels, such as those planned and implemented at the level of municipal territories, remains firmly in the public domain and the responsibility of the States, which were involved in processes of decentralisation (1990-2000 period). There are several explanations for this: the process of decentralization is being implemented in stages and is still ongoing; the municipalities are still young and governed by public accounting rules applied to local authorities; they lack the necessary skills,

5. Cotton companies in West Africa (Mali, Burkina Faso, and Côte d'Ivoire) carried out experiments to introduce 'intermediate technology' small tractors for individuals in the 1990s.

means and personnel to apply their own policies regarding resources; they have not built up any special relationships of trust with banks; and do not have the technical capacity to develop and manage municipal investment programmes.

As a result, the States, engaged in decentralization policies, are the only ones who can presently provide – with the help of national budgets or international aid – for the funding requirements of municipal territories for collective production infrastructure or services for rural actors. Various innovative funding mechanisms and tools have been implemented with territorial authorities.

The conventional mechanisms and circuits via decentralized Treasury agencies

The national regulations governing the public accounts of local and regional authorities entrust State Treasury agencies with the responsibility of hosting the accounts and monitoring annual public budget allocations to local authorities. Nevertheless, several countries, such as Senegal, are trying out minor changes to meet the investment needs of a number of municipalities (transhumance routes, rural roads, infrastructure, shared facilities and services). Thus, investments involving several municipalities were made within the framework of the project to support decentralization and local development (ADDEL, 2001-2009). Community interest groups were created and tested in three departments in eastern Senegal, each with 13 to 15 municipalities. In addition, investment funds for municipalities and infra-municipal organizations were routed through an institutionalized fund opened in the name of the interest group and controlled by the Ministry of Finance. Furthermore, several countries are re-examining their national regulations, scrutinizing local fiscal policies and supporting the capacity building of municipalities in terms of resource policy (integration of remittances, tax base, land, etc.), budgetary monitoring, land management and management of activities decided and undertaken by the municipal councils (Box 35.1).

Dedicated agencies and institutional funds

Several public funding systems to substitute State Treasury sources have been tried and implemented by countries in the process of decentralization, including the creation of national agencies for funding investments by territorial authorities – such as the Local Authorities National Investment Agency (ANICT) in Mali, an agency created in the 1990s, through which the State's budgetary allocations and the dedicated funding from donors reaches 700 municipalities, as well as other territorial adminstrative levels. The Malian example was used by Burkina Faso in 2008 to create a National Fund for the Development of Territorial Authorities (FNDCT) with a national presence for helping mobilize State funds and making them available to municipalities (grant, operation, investment) as also funds originating from external aid. Territorial development projects or decentralization projects (Mali, Burkina Faso) use these agencies/funds to channel and oversee funds available for target municipalities. These intermediary financial operators fulfil their payment and oversight roles. However, their effectiveness is determined to a large extent by the municipalities' commitment and capacity of implementation (planning, decision-making, project management, skills, and human resources).

Box 35.1. Example of Senegal.

In Senegal, following the specific decree of 1966 on the funding of rural communities, decentralization endowment funds are intended to cover the costs of services rendered by municipalities (civil status, transferred responsibilities) and the capital development funds of local authorities are destined for investments by municipalities. These funds, granted by the Senegalese State, supplement the negligible revenue from local taxation (rifles, capitation taxes, bicycles, etc.) and are deposited in the accounts of the municipalities, and their use and management are monitored and ensured by State Treasury agents.

The public funds allocated to municipalities reflect the political will for decentralization and public investment in rural areas. The investment capacity, which was in the order of 3.5 million CFA francs (5000 Euros) in Senegal in the 2000s, has increased steadily and development projects of several donors (PNDL of the World Bank, AFD projects) reinforce this institutional and financial tool through which the State routes funding to rural areas. The annual allocation of investment (excluding for roads) is estimated, on an average, at 150,000 Euros per municipality per year in the AFD projects of the Senegal River valley.

Development funds from local authorities, as well as from ANICT and FNDCT, help finance activities defined and presented by the municipalities, with the help of Community Advisory Centres (CAC in Mali) or support teams to manage municipal ventures that are part of development projects. The reduction in, or the disbanding of, these teams seriously disrupts the work with the municipalities of the State Treasury agencies and other dedicated organizations.

The institutional and financial tools put in place by donor projects

Over the past two decades, the creation or the gradual adjustments of the rules and decentralization institutions have necessitated the mediation by project management units between State services and nascent municipalities. However, the positioning of these project management units, as well as a more secure funding for them, is crucial for their effectiveness and appropriation.

AFD projects consider these project management units to be temporary structures created to host external technical assistance, support project management and implementation by the municipalities (concertation on resources, land management, decision-making, planning, investment, management, procurement, monitoring, etc.), as well as their third-party relationships (with rural society and populations, other municipalities, State services, service providers and other actors in rural areas). They thus help municipalities and community interest groups to prepare concerted action programmes and present them to agencies/funds (State Treasury, ANICT equivalents or dedicated institutionalized funds[6]) certifying the technical quality of the

6. Specific financial tool used in Senegal giving responsibility and decision-making powers for local investments to a community of municipalities (managed as public funds).

documents presented, consistency of the action with territorial development, and the relevance of tools and methods of analysis and concertation. They monitor the implementation and help municipalities create socio-professional associations or management teams, ensure the sustainability of the facilities or the infrastructure (irrigation, pastoral activities, warehousing) and also offer them support to manage their investment budgets.

In a few cases, in order to manage large national programmes, project management units rich in human and financial resources and working at the national scale have been created (Cameroon, Guinea). These units have the capacity of substituting or competing with government/technical services and have become indispensable. The question arises very often of institutionalizing the project management units as national mechanisms for providing management assistance to municipalities, or even of integrating them into municipal services.

Regardless of the channel or the operator, funding the requirements of the territories depends almost entirely on the political will of the States:
– to effectively delegate public investments, which are today still largely captured by capital cities and large-scale infrastructure projects;
– to entrust decision-making and management responsibilities to third parties (municipality, regions) that have the requisite democratic legitimacy;
– to agree to support the decentralized levels of project management by allocating the resources necessary;
– to transfer the necessary means and skills while retaining regulatory oversight and control.

It will also be up to States to encourage local taxation to evolve, by moving away from the notion of a centralized treasury and by revisiting the budgetary nomenclature of municipalities to include local resources originating with the land, contributions of decentralized cooperation and various remittances (mainly migratory).

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Chapter 36

French public aid for development: from a centralized aid for the development of chains to support for decentralization

Vatché Papazian and Aurélie Chevrillon

This chapter presents a broad outline of the evolution of French public aid for development, placing it in the context of major global trends since the independence of former colonies, especially in Africa. It shows how aid has moved from supporting centralized public institutions focused on the development of chains to supporting decentralization. Finally, it reflects a growing acceptance of the territorial scale as a basis to understand and support the dynamics of development. The result is a wide-ranging diversification of development projects and their closer anchoring to local communities.

From centralized administration to decentralization policies

In the three decades following the independence of former African colonies, agricultural development projects supported by France and multilateral institutions favoured productivist approaches and objectives focused on major annual or perennial agricultural chains, primarily relying on public institutions (boards, development corporations of particular chains, development organizations, river basin authorities, decentralized State structures) that had the requisite authority to develop and manage infrastructure, supply inputs and provide credit, disseminate intensification techniques, organize and supervise producers, set prices, and carry out various functions pertaining to the collection, storage, processing and marketing of agricultural products.

The realization of the limitations and cumbersome nature of this managed approach paved the way for a period of questioning, restructuring and reform in the 1990s. The roles and responsibilities of States were called into question, and the restructuring – or even the dismantling – of a large number of public development institutions led to the privatization of production companies and the liberalization of most agricultural

value chains (perennial crops, rice, cotton, groundnuts). At the same time, efforts to organize farmers on the basis of agricultural chains led to the emergence of new actors in the development arena[1] who could express and represent the diversity of positions of rural societies, and who were able to contribute to decision-making and co-management of responsibilities regarding infrastructure and chains.

Thus, the first joint management committees for land allocation and maintenance funds emerged for irrigated schemes, and representative organizations[2] and co-management bodies emerged for the annual price-setting mechanisms; quality assurance or mobilization of specific support funds for various value chains, especially cotton. The advent of co-management in the governance of agricultural chains (for example, cotton, groundnuts, rice) resulted in contractual agreements (framework agreements, planning contracts, engagement letters) between the State, intermediary companies/institutions and farmers' representatives (producer organizations, umbrella organizations, trade unions, water unions) detailing mutual commitments, rights and obligations. These were the earliest forms of interface and sharing of roles and responsibilities between the State (and its departments) – which had hitherto acted and taken decisions all on its own – and the farmers engaged in the agricultural production chains – who had hitherto been confined to the silent role of subordinates.

At the same time, the 1990s were marked by the emergence, especially in West Africa, of a political debate on the need for decentralization, with the dual objective of rediscovering meaning in State action and addressing the legitimate aspirations for local democracy in society. The first experiments (Mali, Benin, Senegal, Burkina Faso) aimed at bringing public action closer to rural societies resulted in a gradual development (at a variable pace[3]) and adoption of decentralization policies based on the principle of the transfer of prerogatives, skills, and human and financial resources from the State to different levels of local authorities with elected legitimacy (regions, municipalities). The administrative division of the national territory mobilized the efforts of legislators, who were more interested at this stage in reshaping the territory for the organization of elections (as a proof of local democracy) than in framing the decentralisation issue in terms of governance based on municipal territories conceived as sets of actors, resources and rules conducive to the conservation, use and management of resources. The adoption of decentralization laws, the first local elections and the formal emergence of new municipal actors possessing some skills (culture, sport, youth, health, education) but equipped with few human and financial resources[4] were able to only partially live up to the real expectations of local actors. They were also unable to undertake any significant actions concerning resources or the reshaping of their territories. Specifically, attention was gradually drawn to the skills required for the management of territorial land and natural resources (pastoral, agricultural, forest, water, fish), as well as those related to territorial planning or its economic development. However, apart from a few exceptions (Senegal), no clear

1. Socio-professional associations, federations, unions, farmers' unions, national coordination bodies, sub-regional networks.
2. FNPC in Senegal, Sycov in Mali, UNPCB in Burkina, etc.
3. Completed between 1995-1996 (Mali, Senegal, Benin) and 2004 (Burkina Faso).
4. Initial budgetary allocations of 5 million FCFA (7500 Euros) per commune.

rules existed for the devolution/transfer of public or private land ownership, forest estate or infrastructure to nascent municipalities (see Chapter 4). Finally, powers for local taxation were not devolved, with the result that the majority of rural municipalities remained dependent for their operations on State funds and on investment projects supported by development partners.

Towards a diversity of projects to support territorial development

From the 2000s onwards, and in an effort to put these principles into operation, France, along with other development partners, accompanied and supported the actors in the decentralization process (State, local communities) by focusing, in association with national governments, on institutional, financial and regulatory issues[5], and, together with local communities, on essential skills for developing mapping tools for resources, potentialities and uses of land (rural land plans, land use and zoning plans, see Chapter 4), planning (local development plans, action and investment programmes), project management and sustainable management of local investments that were desirable/useful for local populations, in domains ranging from social service infrastructure (education, health) to the environment (erosion control, forestry, wood energy, etc.) to productive infrastructure (lowlands, hydraulic or pastoral facilities). Significant technical and financial support was initially extended to all issues of interest to the State: institutional and fiscal reforms, as well as regulatory frameworks for the functioning of municipalities (planning/programming methods, training of elected representatives, local taxation, procurement procedures, relations between local communities and decentralized services).

The issue of the participation of rural societies in the definition and implementation of local development at the territorial level quickly emerged. Operators on the ground (NGOs, researchers, technicians, academics) expressed their interest:
– in systems to allow the regulation of land and natural resources by rural societies and/or municipalities in order to ensure harmonious coexistence between agricultural and pastoral activities within the territories allocated to municipalities, for example (Box 36.1);
– in a deeper understanding of the functioning and internal governance of municipalities, with regard to planning and decision-making concerning resources, land, spatial planning and local investment.

This historical sequence of a transition from a development through chains to a development based on territories has given rise to research and development projects driven by the desire to bring coherence between observed agricultural dynamics and territories. To this end, projects have increasingly moved towards characterizing spaces and undertaking territorial diagnoses: demarcation of land/terroirs/territories, identification and analysis of resources (hydraulic, pastoral, forest), current state of places

5. Skills, resources and means to be transferred, interface between local communities and decentralized services, intermediary institutions to be created (specific development agencies in Senegal, municipal council advisory centres in Mali), financial transfers and local taxation, monitoring and control mechanisms, reforms, particularly those relating to land and taxation, laws and implementing decrees.

Box 36.1. Land as key to action for territorial development.

Land issues, encompassing the totality of man's relationships with the land and the resources it contains, and the relationships amongst men concerning land and associated resources (water, pastures, forests, etc.) is a key aspect of the organization of territories. The way in which a society defines ownership and usage rights over land and natural resources, which it allocates among different actors, and which it guarantees and administers, is both indicative of and defined by social relationships. Land administration thus refers to trade-offs between competing economic roles of the soil. It aims to reconcile the interests of different groups of actors, in compliance with laws and rules. Soil and land management is an essential component of territorial dynamics. As such, it is a key element in development policies. It can help prevent conflicts, as well as be their cause.

A dualism prevails in many African countries and in Madagascar between national land laws – established legally and dating back to these countries' independences – and local 'customary' land practices – legitimized by use over time and based, in effect, on informal and commonly shared rules, which have persisted in spite of recent laws. Over the past 15 years, many of these countries have sought to formulate new policies based on the recognition of this pluralism and on the implementation of a process of decentralization in a context of the devolution of land from the State to local and territorial authorities by combining technical innovations, institutional reorganizations and judicial reforms. Local experiments of social validation and the formalization of land tenure and usage rights ('petits papiers', certificates, attestations, pastoral charters, etc.) as part of projects (Burkina Faso, Senegal, Madagascar, Benin, Côte d'Ivoire) have created new partnerships between actors concerned by land-related issues. They have informed deliberations and even contributed to reforms, for example in Niger, Burkina Faso, Benin, Mali, Madagascar and Senegal: policy-making, the adoption of laws and decrees, recognition of the domain of communities and individuals, conflict resolution, etc. These processes have attracted renewed interest since the raising of public awareness about problems linked to massive appropriations and large-scale agro-industrial investments, territorial conflicts and migration.

At the AFD (French Development Agency), the land-tenure issue dates back to the 1990s in the context of the law on agrarian and land tenure reorganization in Burkina Faso, the establishment of the Land Observatory in Mali in 1992, rural land planning in Côte d'Ivoire, Benin, Burkina Faso, etc. Since the 1980s, land tenure has gradually become a decisive element in imparting consistency to the design of land management programmes in Burkina Faso. This issue was initially addressed by agronomists within the framework of projects to develop agricultural production chains (cotton, coffee/cocoa, perennial plantations, rice), management operations or natural resource management programmes (water, pastoral, forest), development of hydraulic infrastructure, support for local development, the implementation of decentralization, and public and private local investments. In this way, measures were adopted to support production, by ensuring a favourable articulation between the dynamics of the chains (investments, perennial plantations, infrastructure facilities) and territories. A new generation of projects to support 'territorial dynamics' was then proposed,

many of which have been implemented over the last ten years at different levels in several countries – 45 municipalities in Western and Eastern Burkina Faso, 45 municipalities in Senegal (Senegal River valley and Eastern Senegal), municipalities of the fourth and sixth regions of Mali, municipalities in the Central Region of Benin, a municipal land management project in Madagascar, the National Participatory Development Programme (PNDP) in Cameroon, Village Communities Support Programme (PACV) in Guinea, etc. Administration of land by municipalities was thus seen as the best opportunity for emerging local communities to arbitrate and settle conflicts, exercise their skills, generate resources they lacked, and establish their legitimacy, and to become the basis of taxation in rural areas. At the national level, programmes to support political processes for land reforms have been supported (rural code in Niger, land law in Burkina Faso, secure local management for Madagascar's land reform).

All the actors involved in French cooperation (the French Ministry of Foreign Affairs, AFD, research institutes, NGOs) supported these dynamics. A think tank on the land-tenure component of rural development was created for this purpose in 1996. This multi-disciplinary technical committee on land issues has, over the last ten years, published collective work to characterize the observed phenomena and position at the international level (White Paper on land administration and securing rights in the countries of the South, 2009; Large-scale appropriation of land, June 2010; A guide to *ex ante* analysis of large-scale agricultural investment projects involving land 2014; The formalization of land rights in the countries of the South, 2015). More recently, the issue of land grabbing has become a global problem and is being monitored closely by the committee using tools designed and improved by CIRAD (Land Matrix).

and mapping of potentialities, characterization of land tenure systems and systems of local actors, identification of institutional and financial planning mechanisms and implementation of development actions at the local level.

For AFD, this was followed, in parallel with more traditional programmes for creating infrastructure or developing chains, by projects for the demarcation and management of terroirs (Burkina Faso, 1988), the management of natural pastoral, hydro-agriculture or forest resources (Sahelian countries and the Gulf of Guinea), the establishment of the first Land Observatory (Mali, 1992), as well as numerous local development projects (in anticipation of decentralization), projects to support decentralization, and investment programmes for municipalities from their inception (Mali, Senegal, Benin and Cameroon).

As the new municipal architecture resulting from decentralization is being consolidated, the projects have sought to strengthen municipal project management skills and to consolidate the institutional and financial framework of their operations, and have attempted to orient public investment[6] towards rural areas. It has taken all of the decade, and up until the present, to specify the skills to be transferred, as well

6. Until now mostly confined to the central level and capital cities and mainly focused on urban infrastructure and services (water, electricity, transport, communications).

as the issues concerning local authorities and their areas of action. This period was also necessary to improve the methodological, technical and financial tools (national and local) so that the knowledge, decision-making abilities and capacities of action of local authorities could assert themselves. Finally, it was in the past 15 years that various transversal issues (land policy and reform, rural finance, taxation, territorial planning, protected spaces/peripheral areas, agroecology, etc.) led to pilot projects or those involving several countries. These experiments have informed political dialogue amongst national decision-makers, crystallizing, in the process, the common and shared interest of researchers and developers for territorial approaches.

The collaboration between CIRAD and AFD had been centred for a long time on technical and economic aspects of agricultural and agrifood chains. Now, however, with the territorial approach, this collaboration has found fertile ground to associate new disciplines, in addition to agronomy, to improve our understanding of the complexity of situations, to refine methods and tools, to implement institutional frameworks and financial tools, in order to support local or national actors in their decision-making and actions regarding municipal or national territories.

The experience of and lessons learned from these multiple projects, whether local or national, inform policy dialogues. They help support the States' decision-making regarding territorial issues such as the reduction of urban-rural asymmetries, the attractiveness of agricultural activity and rural territories as an alternative to migration, the strengthening of existing solidarities around resources and activities, and the recognition of local government and its role in averting territorial tensions and conflicts.

Chapter 37

Territory-centred thinking and action for a better future: territorial foresight in the regions of Ségou in Mali and Vakinankaratra in Madagascar

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This chapter presents the principles and perspectives of foresight approaches in sub-Saharan Africa, positioned at the level of sub-national territories rather than at the national and international levels. We refer here to large administrative regions, products of a social and political structure that sometimes goes back many decades. For this historical reason, these regions do not always correspond to the characteristics of territories as defined in this book (see Chapter 1), but have been directly targeted by the devolution policies of State services and the decentralization that have been implemented, often in an incomplete manner, over the last three decades. In this chapter, we intend to offer generic analyses, based on two recent studies in the region of Ségou (Mali) and Vakinankaratra (Madagascar).

A need for territory and foresight

The first part of this book shows the pertinence of territorial approaches in identifying new levers of development. To illustrate one of the aspects of accompaniment of the territory, as described in Chapter 31, this chapter presents one example of a broader framework of institutional and political recognition of specific territorial issues in sub-Saharan Africa (see, in particular, AfDB, OECD, UNDP, 2015; Pesche *et al.*, 2016).

Sub-Saharan Africa, despite experiencing a period of strong and significant – albeit unevenly distributed – growth, has not witnessed the economic boom predicted in the 2000s. The effectiveness of the emergence of African economies, whose primarily sectoral translations feature in numerous national dialogues, is being widely debated today (Magrin, 2015). It should be noted that public policies in recent decades have

shown their inability to trigger a process of sustainable development and structural transformation through the diversification of economies beyond the boundaries of capital cities (AfDB, OECD, UNDP, 2015). Poverty rates remain among the highest in the world (41% of the population live below the income threshold of USD 1.25 PPP[1] per day) with large territorial disparities, including a significantly higher concentration of poverty in rural areas. The Sustainable Development Goal no. 10 on inequalities includes the following target: 'by 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average'[2]. Achieving this SDG will require both targeted interventions in the marginalized and fragile rural territories where the targeted population often lives, and innovations in defining and implementing public policies.

The sub-continent faces a demographic challenge of overwhelming magnitude. The projected doubling of the African population by 2050, with 2.1 billion expected total inhabitants on the continent, more than half of whom will be under 25 years old[3], calls for serious reflection on development models that can respond to issues of youth employment, productivity and food. Sub-Saharan Africa, with the exception of a few countries, will be unable to benefit, at least for several decades, from the demographic dividend[4], historically recognized as a lever for economic emergence. Furthermore, the high proportion of the agricultural population in the active workforce (60% on an average), weak employment opportunities in the secondary and tertiary sectors, and the fact that the so-called rural population will continue to grow beyond 2050 constitute an unprecedented and seemingly insurmountable set of challenges.

Therefore, a true structural transformation in Africa cannot be achieved by replicating existing development models. The challenges identified call for a revamping of public policies using multi-sectoral approaches with a territorial scope to address a demographic urgency and its consequences on employment and pressure on local resources. In a context in which institutions born of decentralization are struggling to function and public levers of development have been scaled back considerably, one of the challenges is to get local actors to step forward, take control and determine their future. Territorial foresight offers perspectives to meet this challenge.

Territorial foresight in local strategic reflection

Research and expertise that incorporate consideration of the future in decision-making processes encompass a wide diversity of approaches, methods and tools (EFMN, 2009). This diversity extends from the domains of forecasting and projection, based

1. Purchasing power parity (PPP) is a currency conversion rate that allows the purchasing power of different currencies to be expressed in a common unit. This rate expresses the ratio of the quantity of monetary units required in different countries to purchase the same 'basket' of goods and services. See http://www.insee.fr/fr/methodes/ (retrieved 23 April 2017).
2. http://www.un.org/sustainabledevelopment/inequality/ (retrieved 23 April 2017).
3. UNO, World Population Prospects, updated in 2015.
4. The demographic dividend corresponds to the economic advantage that can be obtained from the relative decrease in inactive populations in the age pyramids following a rapid demographic transition. It is characterized by a leverage effect caused by the high productivity of societies that have a reduced need to allocate resources for the care of children and the elderly.

on rather quantitative methods, to domains of anticipation and exploration, based on relatively qualitative approaches. Foresight approaches, which are constantly evolving, often bring together the tools and methods from both forecasting and anticipation.

The approach implemented here can be defined as a 'reflection to explain the present action in the light of possible and desired future scenarios' (Godet and Durance, 2011). It consists of the co-development of exploratory scenarios by actors who are directly concerned.[5] It is found at the intersection of three types of foresight: strategic, participative and transformative (UNDP, 2015). Its relevance and effectiveness stem from the combination of two approaches: the creation of multi-sectoral and multi-dimensional knowledge which helps better explain change factors that impact the territory's functioning, and the participation of diverse range of actors who enable the transition from a multitude of individual representations to a collective appropriation of the issues.

This approach is based on a reflection that identifies and differentiates exogenous forces and trends over which local actors have little or no control, and local forces and rifts that these same actors can control or influence. The latter are at the heart of the territorial action that inserts local actors into decision-making processes and action courses in order to influence their development trajectories. Applied to the regions of Ségou and Vakinankaratra, it opens a range of possible futures to help reconcile the long-term challenges of development with territorial resources and local margins for manoeuvre. It allows these territories' actors, who may feel helpless in the face of changes at a global or national scale, to retake, at least to some extent, control of their future, by using the future to change the present to change the future. We are thus referring here to actionable territorialized foresight.

Matching and combining viewpoints to imagine possible futures and think the present

The methodological construction presented here is the result of a journey from a request for expertise to a finalized research programme for facilitating local public decision-making. Based on the specifics of the African context mentioned above, the hypothesis that guided the request for expertise was that the continent's demographics – in terms of spatial distribution as well as in the number of individuals and the age structure – are exhibiting an important trend that will have a marked impact on the future of African rural territories. The initial methodological proposal sought to break down future demographic challenges to the local level in order to predict their impacts on the labour market, needs for basic services and natural resources, as part of a foresight reflection on the future of these territories in the medium term. Subsequently, the proposal took on a broader strategic dimension

5. The participatory methodology used is described in the respective reports (in French) of the workshops conducted in Ségou and Vakinankaratra. They are available online at: http://www.afd.fr/webdav/site/afd/shared/PRESSE/Evenements/Rapport%20d%27atelier%20les%20avenirs%20de%20Segou%202035%20final.pdf and http://www.afd.fr/webdav/site/afd/shared/PRESSE/Evenements/Rapport%20d%27atelier%20les%20avenirs%20de%20Vakinankaratra%202035%20final.pdf (retrieved 24 April 2017).

by being enriched with complementary and more predictive approaches, as well as with long-term territorial diagnoses that highlighted the trajectories of the territories studied and the challenges they will have to face. Finally, and especially in the countries concerned, the statistical systems available are of little help in describing correctly the informal sector, the concrete realities of living conditions and, above all, the representations of households. It thus became necessary to carry out a survey to collect first-hand data that could contextualize secondary data provided by national and international institutions.

The studies, from diagnosis to exploratory foresight, and thence to strategic foresight, have thus combined various disciplines and approaches, conducted jointly and organized into four major blocks:
– a retrospective diagnosis that integrates and leverages secondary data produced by national statistical entities, analyses of pre-existing diagnoses, as well as lessons from major socio-economic surveys that are conducted regularly;
– open interviews with key people and surveys[6] covering 500 individuals in each region, to gather additional information on demographic processes and activities, and on the territory's representation and its functioning;
– regional demographic projections, based on original fertility and mortality assumptions, generated within the framework of the study using data, where available, from a recent census and from the United Nations; these projections reveal the challenges to be encountered at time horizons of 2035 and 2050, and help assess impacts of population growth on needs of employment, agricultural land, education and health;
– finally, a more comprehensive projection into the future that identifies the territorial forces of change, undertaken in a participatory manner with a group of experts in the concerned territories, in reference to the previous stages, and which helps develop various likely development scenarios.

The regions of Ségou in Mali and Vakinankaratra in Madagascar in 20 years: what lessons can be drawn?

The diagnosis: urbanization, mobilities, weightage of the informal sector and primary specialization

The studies relativize the magnitude of urbanization. Observed at the regional level, the process shows that a strategic focus on the city would be misplaced. While population growth is greater in urban centres than in rural areas, the predominant role of national capitals in the process is decisive. Rural areas in both these regions are becoming more densely populous and secondary cities are struggling to emerge as economic hubs. Moreover, the observed urban configuration challenges the validity of agglomerates created by the major boroughs and their areas of direct influence (their hinterlands) as territories for action and development. This finding suggests that

6. Quantitative and qualitative surveys using both closed and open questions. Direct surveys of a large number of households were preferred to focus groups in order to capture variability and avoid a partial and possibly standardized representation of the actual reality.

researchers should consider larger areas which have also seen an increase in population density. Finally, many households categorized as urban in various statistics are engaged in agriculture and practice partially rural lifestyles.

Mobilities, especially sub-regional, often over short distances and seasonal, appear to be fundamental to the actors' practices and the structuring of territories. They result from economic and social needs and further blur the distinction between urban and rural categories. They partially challenge the very notion of the rural exodus, which is still regularly advanced as a significant element in regional and, especially, national diagnoses. Mobility constitutes a potential wealth, a territorial asset that deserves to be known, better understood and leveraged by appropriate policies.

Regional economies rely mainly on the informal sector: family farming in which systems of activities that include activities from other sectors (services, handicrafts, trade, etc.) and small urban professions dominate. Consequently, raising resources through local taxation poses a challenge since formal employment accounts for less than 3% of the working population. Economic diversification, as measured by the distribution of jobs, remains severely limited. Agriculture remains predominant but with low labour productivity. Sectoral policies affect only a small part of the active population. Vakinankaratra is known to be an industrial region (especially in the textile and agrifood sectors), where efforts to improve infrastructure have so far focused on public goods usable by industry (electricity, airports and freight, access to water), while the agricultural and rural sectors, home to the bulk of the working population, finally end up with reduced allocation of resources.

Demographic projections: the regional level reflects the continental challenge

Population projections for 2035 predict an increase, over 2015 levels, of 2.5 to 4.2 million people in Ségou and of 2 to 3.1 million in Vakinankaratra. The associated educational and health needs are likely to be ill met by the limited availability of resources. It seems unrealistic to expect these regions to conform to UNICEF and WHO standards by the year 2035, since that would entail providing education to more than 550,000 students, and training over 1,750 health workers in Ségou, with the respective figures being 350,000 and 1,000 for Vakinankaratra. These figures translate into an almost 50% increase in what has been achieved – often with very poor quality – over the last two decades. Furthermore, due to the inadequacy of public allocations, well below necessary levels, competition exists between social investments and investments that have an economic scope, resulting in trade-offs that always turn out to be detrimental to comprehensive strategic thinking, as they often expediently favour short term goals.

The projected increase in rural population densities and requirements of agricultural land is also likely to increase the already high stress on land tenure and natural resources, especially in Vakinankaratra. The growth in population has been accompanied by an expansion of cultivated lands and pastures with little or no gain in productivity, except in localized areas that were favoured by public policies and projects (most notably the irrigated areas in the Ségou region). There is a lack of

data on the availability of land for sustaining such an approach, but the estimated needs for additional land, assuming constant productivity and similar farm structures (almost 100,000 hectares in Vakinankaratra and more than one million hectares in Ségou by 2035), exhorts us to anticipate great changes in production systems[7] and increased competition between conservation and exploitation. Finally, the cumulative employment requirements over 20 years will amount to 1,000,000 jobs in Ségou and 700,000 jobs in Vakinankaratra, corresponding to an employment generation rate that is double of that estimated for the last two decades. It is also worth noting that current employment structures have very little diversity.

The exploration of likely futures: drawing up of exploratory scenarios

The results of the surveys and participatory workshops have led to a better understanding of the representations of local actors. Issues pertaining to the security of goods and people emerged as important from discussions held with the respondents. In Ségou, these concerns arise from the ongoing political and religious tensions, emblematic of the current jihadist threats on the continent. In Vakinankaratra, on the other hand, the apprehensions are the result of the menace of bandits and delinquency. Closely linked to security issues, the inadequate public investments in markets and services, as also the mixed records of institutions responsible for implementing decentralization, are of far greater concern. Furthermore, they are the cause of the disenchantment of the populace and officials.

Despite the alarmist nature of population projections, individuals surveyed – especially in the Ségou region in Mali – were in favour of the security and strength that a large family provides in an uncertain environment. The ideal number of children desired per woman remains higher than four, a sign that a demographic transition could take much longer than expected.

In both regions, agriculture is currently in the limelight, with a focus on agrifood and industrialization perspectives, including of production, although respondents do not envisage a sudden acceleration of economic diversification. Migration (especially to the capitals) and an exit from the agricultural sector are commonly seen as the main alternatives to agricultural pursuits. The results of the surveys showed contrasting perceptions between Vakinankaratra and Ségou. In the former, a large majority of young people interviewed imagined their future primarily in their region and in family farming. It was the opposite case in Ségou, where a majority of the young people envisaged their future elsewhere, especially in the capital, but also in foreign countries. Thus representations of the future seem to be complex and are sometimes out of sync with policy orientations focused on agribusiness and industrialization.

7. The intensification of agricultural production is a historical response to increases in population density. The fact that the density thresholds have not yet been reached would explain the low agricultural labour productivity in sub-Saharan Africa. However, in addition to the uncertainty over the measurement of these thresholds and the rapidity with which it should take place, intensification is a real challenge. Farm managers and owners who will likely have to make the transition are probably already born and the investment capacity to increase productive capacity is low.

Workshops on participatory foresight validated bibliographic analyses and the surveys, while introducing an additional dimension based on participants' experiences. The identification and definition of variables that most influence the territory's possible futures, using which the scenarios were formulated, are presented in Table 37.1. They highlight the diversity of the dimensions of development, the foremost of them being security and governance. Although they are immutable key variables, they are often overlooked by decision-makers and often enough by the rest of the stakeholders.

Table 37.1. Key variables identified in the two regions.

Key variables identified in the two regions	
Ségou region	**Vakinankaratra region**
Security	Security
Mining potential	Access to energy
Communication infrastructure	Demographic pressure
Weightage of the informal sector	Capacity for economic organization
Access to energy	Financing local development
Orientation of local development	Socio-economic structuring, structural inequalities
Public funding	Poverty
Territorial governance	Marketing opportunities

The capacity of national and regional administrators to invest in the territories (mainly energy, accessibility) and to provide local strategic directions in line with the economic environment appears to be a major cause for bifurcations of the trajectories. Otherwise, there is a risk of a falling back on a fragmented self-reliance and self-organization.

The scenarios highlight the fact that without a strong and articulated response at the local and national level, territorial resources of these two regions will not help reduce poverty or the vulnerability of their peoples in view of population projections and past trajectories. This necessitates a revamping of public policies, which should henceforth be based on concerted strategies for territorial development. The derivation of value from its resources should rely on an improved knowledge of their availability (especially land), and on a better understanding of their local uses in the long term.

Two future scenarios[8] are presented schematically below as examples. The one chosen for Ségou illustrates an endogenous strategy based on exploiting the potential of regional territories and their own tangible and intangible resources in response to demographic challenges and income diversification. The development of modest but diversified economic structures depends on improved local governance, especially as concerns redistribution. The scenario selected for Vakinankaratra not only reflects concerns for the safety of goods and people in the territories and its possible impacts, but also for widening inequalities. The territorial segmentation induced further aggravates management capacities, especially of managing the demographic issue.

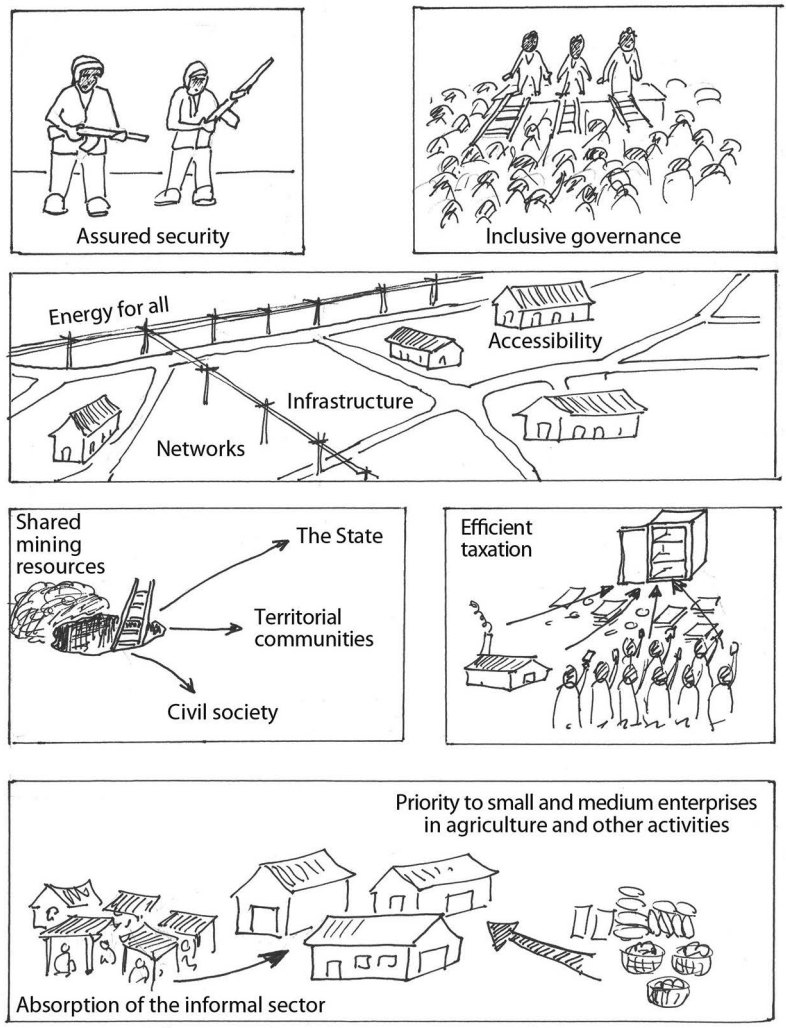
8. All sixteen scenarios discussed can be consulted in the study's summary documents (Sourisseau *et al.*, 2016).

Some suggested orientations for public action at the conclusion of this exercise: the example of agriculture

The work carried out allows stakeholders to identify a number of strategies and actions to achieve the desired future(s). Since the agricultural sector represents a key solution for the future of these two regions, the reflections resulting from this exercise are presented here for illustrative purposes.

To build an agricultural model that offers decent jobs and acts as an engine of multi-sectoral development, it is necessary to complement the historical production objective of agricultural policies – essential to achieving food and nutrition targets – by adding other dimensions of environmental and social sustainability. To this end,

1. Long live Segou, small and family are beautiful…



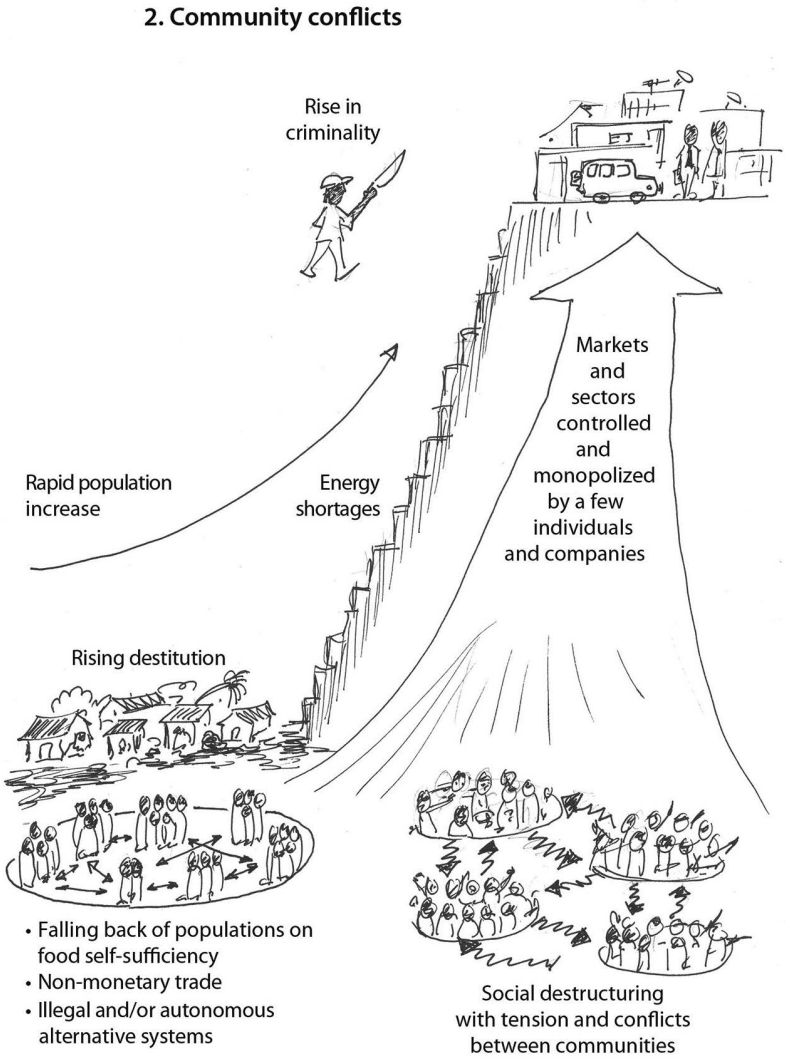


Figure 37.1. Illustration of two of the sixteen scenarios developed.

1. The scenario in the Ségou region © J. Mercoiret.
2. The scenario in the Vakinankaratra region © J. Mercoiret.

perspectives of a family-based and labour-intensive agroecology that can increase economic and social performance, both in the production segment and all along the food systems, merits further exploration. At the current time, such an orientation offers greater guarantees of employment and economic diversification than agri-businesses and concentrated food systems. It is important to strengthen the link between agriculture and upstream and downstream activities, between cities and the countryside. This presupposes a willingness to rebalance rural settlements, secondary towns and regional capitals that provide services and infrastructures to help diversify activities and jobs.

In addition, this study calls for a rethinking of the rationales of decentralization, not only through a strengthening of local capacities of management, organization and strategic construction, but also through a recasting of national development organizations (agriculture is a good example here, too) which would allow a freer and more effective expression of regional preoccupations.

The perspectives for territorial foresight approaches in sub-Saharan Africa

This experimental method, which is neither prescriptive nor normative, combines information of different origins and types to arrive at a combination of useful perspectives to avoid the imposition of purely sectoral approaches on regions. The participatory dimension of the exercise of projecting into the future and the resulting collective dynamics appear to be veritable assets to give a voice to actors who are rarely heard (not only some category of representatives of civil society, numerous young people and marginalized populations, but also dissenting voices within development administrations). They facilitate a common understanding of regional challenges and of the capacity of local resources to respond to them. The collective workshops highlighted the lack of communication and of the synergies that must be found and maintained.

These experimental studies offer perspectives to move forward from deliberating on possible future scenarios to defining a viable and shared territorial project that could help gradually reject an approach that is too often influenced by international cooperation, relies on highly sectoral public investment models, and is based on reproduction of existing models that ignore the local context (or the social, economic and institutional environment). The knowledge produced and the collaborative dynamics initiated thus make it possible to discuss and evaluate the effects of particular local policies, test their relevance and imagine alternatives. On this basis, it seems quite feasible to support development strategies that are local and territorial, participatory and multi-sectoral, and which take into account the capital of the territories in their diversity: economic and natural, but perhaps also human, social and cultural. However, their management and implementation will require an effective decentralization, and stakeholders will have to possess the human and financial resources to achieve it.

Beyond these concrete perspectives at the level of the transformation of the territories concerned, the territorial foresight approach based on a joint development of exploratory scenarios appears as a potentially innovative element in local governance. Indeed, it participates in a process of transforming administrative systems at the local level by affording the actors concerned with the means to become aware of their capacity for action both at the infra-territorial level as well as in their interactions at the national level. This approach thus contributes to the reflection on decentralization policies which, due to the choice of an administrative region as the study area, have been discussed at length in the experiments presented here. Territorial foresight not only offers opportunities for a better understanding of strategic planning in the context of territorial development, but it can also impart local actors with specific skills and a state of mind in sync with the expectations of decentralization.

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Chapter 38

General conclusion and outlook

Élodie Valette, Patrick Caron, Geo Coppens d'Eeckenbrugge and Tom Wassenaar

Across countries and world regions, and for different reasons, there is a persistent fear that current trends will ultimately lead to a complete marginalization of rural territories. Instead of subscribing to the often-expressed fatalistic view that rural populations will relocate to ever larger metropolises and that agricultural production will then find itself concentrated in a few breadbaskets, we have chosen to explore ways in this book that show on the contrary how strong are the dynamics of development in rural areas and how vibrant the innovation processes. The analyses and experiences shared here demonstrate various ways of preserving the vitality and diversity of rural territories, of making them more dynamic and of building up their ability to contribute to the challenges of sustainable development, including at national and global scales.

What, finally, is a territory?

Over a span of just three decades, the term 'territory' has become a ubiquitous term, not only in the proliferation of publications that appropriate it, but also in its increasing mobilization in public action (Chapter 3). The term is generally perceived as a platform for virtuous dynamics: crucibles of participatory approaches, territories are considered laboratories in which new forms of governance are invented and tested. As frameworks for sustainable development, territories are expected to allow the emergence of alternative and pluralistic models of development, in contrast to the exclusive dominance of a model based solely on economic growth and competition (Chapter 2).

All of the contributions collected in this book subscribe to these perceptions, offering an overview of the forms and modalities of the use of the 'territory' in research concerning rural areas in the Global South and in their development. The second part of the book consists of short chapters describing work done and experiments conducted in which the territories described are far from constituting a homogeneous frame of reference. The differences between them pertain to the themes addressed, the contexts, the definition, concept and perception themselves of the territory, and,

finally, the way in which territories are mobilized in research activities and in action to meet the challenges of development. The structure of the book attempts to account for and illustrate this diversity (see the Introduction).

We note that the concept of the territory results from the embedding in the geographical space of a set of social, economic, cultural and political processes involving the participation of systems of local actors and of those external actors who are involved locally (Vanier, 2009). Nevertheless, given the diversity of situations, trying to define the territory remains a tall order, and it is futile to try to reduce the notion to a single definition (Lévy and Lussault, 2003). Our own conception is pluralistic and it is in this sense that we have chosen to approach similar notions such as that of the landscape (Chapter 1).

Similarly, the manner of addressing the territory varies and there exist a great diversity of analyses depending on the disciplines concerned. Scientific approaches often oscillate between an analysis of the territory as a 'political subject' or a 'social subject' (Vanier, 2009). Social geography is more concerned with the territory's dimension of identity, and thus highlights relationships of belonging and anchoring (Di Méo and Buléon, 2005) and their impact on the organization of geographical spaces. Political geography, on the other hand, endeavours to shed light on the representation of the territory by studying the mechanisms of public action (Debarbieux and Vanier, 2002; Faure and Négrier, 2007). The approaches to the territory as 'ecological subject', 'agroecological subject' or 'technical subject' are not far behind, and give rise to the exploration of the diversity of the biological and technical processes that take place there and the actions implemented to steer and act on these processes.

The themes addressed in the second and third parts of this book illustrate these multi-faceted approaches. The chapters in these parts deal with territories with very variable dimensions and contours. In some cases, the territories are imposed and thus demarcated by political and administrative boundaries, those of the territorial authority (as in Chapter 7, which discusses a territorial public policy, with a clearly delineated municipal boundary). Elsewhere, territories can be entities marked out by a specific boundary pertaining to particular infrastructure facilities or a legal status and constituted around the management of resources, whether protected areas (Chapter 24), irrigation schemes (Chapter 5) or forest concessions (Chapter 30). Territorial boundaries may also correspond to the precise limits of biophysical characteristics, as in the case of watersheds analyzed through the establishment of an observatory (Chapter 34). They are sometimes defined by the identification of the territories of life of their inhabitants (Chapter 27). Other studies deal with a territory with blurred and shifting contours, defined by a development issue: this is the case of health management in Chapter 14, the control of agroecological processes (Chapters 15, 16 and 23), processes of appropriation (territorialization in the context of cashew nut cultivation in Burkina Faso in Chapter 26 or the stabilization of agricultural frontiers in Amazonia in Chapter 7) or processes of innovation, and of the search for 'spontaneous' coordination and synergy (Chapter 8 in the domain of fish farming, Chapter 18 for livestock farming, Chapter 21 for the strengthening of agrifood systems, Chapter 22 for waste recycling). These territories are sometimes

even those of migration or mobilities, whose changing and flexible boundaries are defined by the exchanges between actors and their representations of what binds them together, such as the multi-sited territories discussed in Chapter 20. Thus, some chapters refer to the territory in the administrative or institutional sense of the term and to the design or implementation of public policies and territorial governance (combining policies of conservation with those of development in Mexico in Chapter 28 or encouraging territorial development policies in Brazil in Chapter 29). Others concern the constitution and institutionalization of territories whose relevance derives from the engine and the social group that drive them (protected areas and forest concessions in Chapters 24 and 30).

The political contexts in which these territories are situated also vary. The State's intervention in local life may be stronger (as in Tunisia, Chapter 27, or in Brazil, Chapter 29) or more muted (as in Burkina Faso, Chapter 26), depending on the how far along are the processes of decentralization. Diversity is also found in legal and fiscal contexts, as shown in Chapter 35, which focuses on funding mechanisms and tools. And, finally, diverse too are the land-tenure and migration dynamics, as in the case of agricultural frontiers (Chapters 7 and 30), intersecting with those of long-demarcated areas, including administratively. These ever-changing contexts are thus those of differentiated forms of territorial frameworks, in which the nesting of the territorial hierarchy sometimes gives way to multiple and embedded territories, defined by their own drivers and challenges.

The book thus offers a panoramic overview of territorial diversity but also of the complex processes of embeddedness discussed in its first part. It thus illustrates that the 'contemporary production of local territories no longer depends exclusively on the administrative framework of the national territory on the one hand, nor on the management of municipal public services on the other, but rather on a logic of a search for multi-faceted territories of development, in the sense of spaces of mobilization of various potential actors of local development around a project' (Antheaume and Giraut, 2005). It reveals the capacity of rural territories to ensure stability and security (OECD, FAO, UNCDF, 2016). It shows how agriculture – the world's largest employer – can contribute to a revival of these rural territories so that they can provide their inhabitants and, more globally, the whole world, the full gamut of economic, social and environmental services essential to peace and social cohesion: well-being, food and nutritional security, human and environmental health, anticipation of and adaptation to climate change, energy transitions, distributed economic growth and decent jobs, equity, and anticipation and prevention of disputes and conflicts.

The territory: an innovation framework and a space for coordination and regulation

Despite the diversity of contexts, reference bases and issues, the case studies presented in the book demonstrate marked convergences. In particular, they highlight increasing recognition of and recourse to the concept of the territory. As in the case of tropical agricultural chains (Biénabe *et al.*, 2017a), the territory exhibits its capacity to behave as an innovation framework and a space for coordination and regulation.

The territory as an innovation framework

The territory constitutes a framework for social or technical, organizational or institutional, individual or collective innovation. Thus, with the territory as framework, new forms of management of resources (subpart 2.1), of organization of agricultural production (subpart 2.2) and services – especially environmental ones –(subpart 2.3), of derivation of economic value from specific resources (subpart 2.4) and of design of public policy (subpart 2.5) are devised and implemented.

Using the example of the expansion of fish farming, Chapter 8 shows how innovation can be based very decisively on territorial characteristics and how it is thus stimulated. In the case of Guinée Forestière (Forested Guinea), it is based on deriving value from the many lowlands and the collective know-how on rice cultivation, leading to a mutually beneficial association between these two activities. We see here, as in the other examples, how closely interwoven are the biological, technical and institutional dimensions of the processes of innovation.

In other words, the territory produces innovation and specifies it. On the role of territorial planning in innovations concerning cropping systems, Chapter 11 shows that organizational innovation can be a prerequisite for technical change. It shows how the dissemination of a new cropping system may require a reorganization of uses between agriculture and livestock husbandry and, for this reason, coordination between the various territorial actors.

However, the territory is more than a mere framework mobilized for innovation. Localized agrifood systems presented in Chapter 21 illustrate this capacity of territories to stimulate the emergence of organizational and institutional innovations, to themselves become drivers of change. The derivation of value from products of terroirs is certainly the most striking example. The case of organic waste recycling, based on a system of interdependencies activated at the territorial level through a new organization of organic matter flows (Chapter 22), is another example of innovation conceived and implemented by and for a territory's actors. Because of the proximities and the forms of social capital that constitute it, the territory is, in fact, a form of organization that permits the internalization of certain transaction costs, the minimizing of economic risks, the facilitation of learning processes, the leveraging of know-how and traditional knowledge, the guaranteeing of the application of quality criteria to a product or a form of production, etc., all the characteristics that make it an asset that can be mobilized in the processes of production, especially agricultural production (Angeon *et al.*, 2006; Pecqueur, 2004; Gumuchian and Pecqueur, 2007; Courlet and Pecqueur, 1992; Boucher, 2004). As the examples in this book show, the projection of a territory in the future and in its environment, and in what are known as 'competitive advantages', thus depend fundamentally on its ability to explore its biophysical, social, economic and institutional specificities, and, through innovation, derive value from them.

In all the examples described, the territory's organization is the basis and cause of the dynamics of innovation: access to resources of land, labour, production and exchanges are inserted in a local system of social and power relationships whose unique

combination stimulates (or, on the contrary, hinders) the dynamics of cooperation, coordination and information generation and sharing. The concepts of networks of social actors and of governance are thus central to this capacity for innovation. And these innovations transform territories in return. Chapter 25, focusing on the analysis of learning processes in territorial development projects in Brazil and Bhutan, explores this dual issue of the coordination processes at work in innovation and their impact on the territory concerned. It shows how territories are transformed through reflective practices carried out by their actors.

Finally, these examples illustrate how innovation also helps make territories more resilient. On the management of pests in an insular context, Chapter 15 shows how this resilience and the adoption of new practices depend on the articulation of a precise knowledge of epidemiological and bioregulation phenomena with an integrated organization of the sector and the management of the territories by the actors.

The territory as a space for coordination and regulation

Given a problem to be solved or an opportunity to be seized, territories are frameworks of collective action within which a community of interests and action can be identified. Very notably, territories are the meeting place between institutional development projects and local initiatives. New forms of territorial governance are proposed that are based on coordination between producers, i.e., users of a shared resource. Emphasis is placed on organizations that eschew a hierarchical and vertical form of government and instead adopt horizontal coordination, concertation and negotiation. We move from the governance of rural areas by a single authority to a set of governance processes in which all the actors share authority. Power relationships seem to be supplemented, and even sometimes replaced, by new forms of solidarity: professional solidarity, neighbourhood solidarity, class solidarity, solidarity of user communities, and solidarity of interests (Godard, 1993; Lascoumes, 1994).

It is this type of governance that Chapter 14 invites us to recognize and promote for an improved management of human and animal health. In a similar way, Chapter 16 shows how a territorial approach to the control of invasive species is based on mechanisms of concertation and coordination between all the actors, with an agreement on the actions to be implemented necessarily based on a comparison of the various points of view. These examples furthermore show that the territory is also the framework for the application of standards or reference bases of action, whose construction not only concerns the local environment but also strongly influences the design of national and local policies. These increasingly numerous standards are modifying the modalities of local public action. But they are also translated, i.e., adapted, circumvented, diverted and reinvented, by local actors, so that they can in turn circulate and spread to different levels of organization and possibly themselves contribute to change. This is what Chapter 14 shows, as does Chapter 35 in the context of the financing of development projects.

This regulatory function is also expressed in the domain of land tenure, whether it is to affirm the importance of legal pluralism (Chapter 31) or to anticipate problems

of land grabbing (Chapter 4). This function is essential to address environmental concerns: taking issues of sustainable development in an agricultural frontier context into account (case of Amazonia in Chapter 7), organization of production services (Chapters 15 and 17), the use of biodiversity through the creation of protected areas (Chapter 17), the control of invasive species (Chapter 16), the organization of waste recycling chains based on territorial ecology (Chapter 22), etc.

The regulatory capacity of the territory plays a crucial role in another area, as illustrated in Chapters 12 and 13 in relation to the production of palm oil and rubber: by supplementing, stimulating or qualifying the capacity for innovation and coordination within agricultural chains (Biénabe *et al.*, 2017a), it paves the way for the necessary reconciliation between economic and commercial dynamics and the challenges of sustainable development. As Giraud (2017) points out in his Foreword to *Sustainable development and tropical agri-chains*, 'It is at the meeting point of the agri-chain and the territory that the future of agriculture will largely be determined.' We have also shown in this book, especially in Chapters 12 and 13, that while it does not solve all the problems, the territorial anchoring of economic sectors allows local actors to take on the risks brought about by the volatility of investments and production circuits and the asymmetry of power relationships. It allows them to negotiate and define the terms of a sustainable development.

The seductive hypothesis of the territory as a privileged setting for the emergence of collective actions must however not lead to an idyllic vision. The territory can be the framework of conflicts and exclusions. This is discussed in particular in Chapter 26, which shows how the processes of territorialization can involve power balances and lead to the exclusion of certain actors. The development of certain territories is also likely to occur at the expense of others, geographically close or distant.

The territorial organization can then demonstrate its capacity, or the lack of it, to take on an active role in reducing imbalances and tensions by resolving inconsistencies between individual, collective and public initiatives. In doing so, the territory becomes the privileged field of application of new governance processes, not only at the interface between collective action and public action but also at the interface between the State and the market. As Elinor Ostrom pointed out in reference to the commons at conferences in 2011 in Montpellier and Paris[1], the territorial approach would henceforth more than simply compensate for the failures and correct the 'externalities' of the two conventional registers of regulation.

Asserting this capacity for regulation does not mean that the territory has to be reified. We do refer emphatically to a plurality of territorial configurations and a plurality of configurations of actors and projects inscribed in geographical spaces of varying dimensions. And we do not ignore the importance of positioning territorial processes in more encompassing ensembles. Indeed, bottom-up change by the local is not the only change that takes place. This book defends the idea that the territorial approach is also a privileged path to sustainable development at a global scale.

1. 'Neither the State nor market: organization of community resources' and 'Toward a third way between State and market for collective and solidarity management of environment and resources'.

The challenges of knowledge production: a research and development agenda

To better accompany territorial actors in their quest for sustainable development, the research community and development practicioners have to equip themselves to better understand and act. This is why we have devoted one part of this book to the tools and methods of territorial development. In fact, support for development constitutes one of the major issues and challenges of action research directed towards rural areas in countries of the Global South. The type of research we are defending must, in addition to its role of expertise and of technical and technological invention, also possess operational tools for observing and analyzing a complex and uncertain world. This implies being able to design, implement and/or get involved in mechanisms of accompaniment (Chapter 31). These systems and the tools used have to be adapted as necessary in order to address the diversity of situations and objectives encountered. The special role of the use of spatial information in participatory approaches for accompanying territorial development is worth noting and we discuss it partly in Chapters 33 and 34. Mental maps, zoning based on actors' representations (Caron, 2011), role-playing games, simulation games, companion modelling, participatory geographic information systems, observatories, etc.: the proliferation and the methodological flexibility of the mechanisms implemented by the research community in this area command respect. Each of these tools and mechanisms is used to represent the territory and its inhabitants and give them voice, using the power of the map to show, invent and explain the territories and the world, as well as to compare and reconcile the actors' various viewpoints. In these observation and analysis systems, the identification and interpretation of controversies, and even of conflicts, forms an integral part of territorial accompaniment. Action research aiming for an understanding of the dynamics that animate and drive territories must therefore pay attention to and attempt to understand discordant voices, as well as encourage marginalized social groups, whose voices are usually inaudible, to speak up. As we see in Chapter 31, such an approach calls into question the researchers' postures and practices, as well as their conceptual and methodological equipment, and calls for an improved formalization of the learning identified in such research. Three main lines of reflection emerge.

Rethinking performance and its multidisciplinary assessment

Accompanying territorial dynamics requires a rethinking of assessment of performance. As Biénabe *et al.* (2017b) emphasize, the sustainable development goals necessitate a complete review of the measurement of performance of agricultural activities and require 'the linking of criteria, indicators, and standards resulting from, on the one hand, political trade-offs required by the local situation, and, on the other hand, a globally negotiated framework.' Such an assessment focuses on activities and their consequences at the territorial scale, as illustrated in Chapter 32 in the environmental domain. The multifunctionality of agriculture and rural spaces, as well as sustainable development, require that any assessment has to take into account a range of induced effects such as the creation or loss of jobs, carbon storage, or the risk of long-term conflicts, including distant ones. The assessment of territorial 'performance'

thus raises the question of the recognition of services and 'disservices' rendered, an aspect popularized by the Millennium Ecosystem Assessment (MEA, 2005; Costanza *et al.*, 1997). It calls for the design of compensation mechanisms for the former, and sanctions for the latter. It raises important methodological and ethical issues, since the assessment process itself contributes to the strengthening of the competitive dynamics of territories (Chapter 3). Thus, rather than a sector-by-sector division of tasks, the imperatives of sustainable development call for new assessment procedures that are based on interdisciplinary points of view on complex subjects. Long-term assessments, over periods longer than those of specific activities or projects, increase the relevance and importance of the observatories mentioned in Chapter 34.

This challenge of assessment is thus considerable, requiring the collaboration of experts from the life, human, social and engineering sciences. It invites researchers and experts to commit themselves even more to the specific institutional mechanisms by which this assessment becomes meaningful (Biénabe *et al.*, 2017b).

Strengthening the regulatory scope of the territory

Even though we have asserted that the territory has the capacity to contribute to sustainable development, this assertion deserves to be backed by better documentation, including in a comparative manner, since the questions being raised today are so new.

This book does not pretend to address every single issue that pertains to the territorial question. It restricts itself to dealing primarily with agricultural and rural spaces. Some topics require more detailed study to define the territory's regulatory scope. While the urban dynamics, for example, are not covered in the book, they have close links with the countryside, as highlighted in several of the chapters, and any look at the territory must incorporate urban-rural relationships (Chaléard and Charvet, 2004). The rethinking of the relations between these worlds that are too often opposed is crucial.

Moreover, we agree with the conclusions of the recent book by Biénabe *et al.* (2017b) on agricultural chains to affirm how the articulation between the chain and the territory is essential for taking environmental and social issues into account. While the economic, social, political, ecological and agronomic dimensions are too often viewed and addressed each in isolation, accompanying this articulation necessitates adopting new viewpoints. Thus, territorial mechanisms must recognize and address the issues of chains, in particular those concerning the insertion of actors and macro-actors such as small and medium enterprises. In this context, we have before us a vast field of action, investigation and follow-up to commit to.

To discuss territories requires adopting an inter-sectoral and inter-territorial perspective, i.e., one of understanding and analyzing local situations in terms of their interactions with close – as well as distant – spaces and territories. More generally and together with urban-rural relationships, the forms and impacts of decentralization, public territorial planning policies and the characterization of food systems on a regional scale deserve more attention in the future. They will be essential to any realistic foresight.

The affirmation of this regulatory scope finally refers to the linkages between the local and the global, between local social and political constructs and global regimes. The territory connects actors and processes acting at different scales, imparting relevance and meaning to efforts for territorial planning. Better thought out, it will be possible to 'avoid, on the one hand, the reliance on the very local and, on the other, the exclusive control by international mechanisms and a centralizing rationale' (Biénabe *et al.*, 2017b).

Thinking and acting at different scales for sustainable development

On the basis of their accumulated experience, as illustrated by this book, research and development institutions can contribute in greater measure to innovation and territorial development. There is a gap to be bridged between analyses and diagnoses conducted at a distance, on the one hand, and action research, on the other. In particular, the setting up of territorial observatories, discussed in Chapter 34, is still too dependent on the opportunities that emerge and where they emerge. The issue is of mechanisms that involve all the actors, possibly based on territorial foresight (Chapter 37), in order to identify and prioritize the situations and issues that need to be addressed. It is thus important that the proponents of these types of observatories communicate and demonstrate the value and benefits of such investments. These observatories are not solely for observation. Co-production of knowledge is conducive to more effective foresight, as well as to the design, implementation and monitoring of interventions. This is also true for the so-called 'symbiotic' opportunities in territorial ecology, where research can strengthen its role both in their identification and then in their design, as illustrated in Chapter 22.

More broadly, at all stages of the support of territorial development, research and development institutions can, by involving themselves in the intervention mechanisms and using appropriate tools, contribute to the identification and design of innovative and relevant solutions, the experimentation and evaluation of these solutions and their use and adaptation. The field is vast and the requirements significant when it comes to the management of living organisms or ecosystems, new technical processes to produce or process better, the funding of activities, the development of policy and standards, or the organization of public aid.

But it is unlikely that the 'large-scale impacts' so fervently sought by development agencies and donors to meet the challenges of Agenda 2030 will result only from a replication of local operations and success stories. Indeed, even if they are necessary and replete with valuable lessons to be learnt, success stories from one place are rarely reproducible and extrapolatable elsewhere because of their specificities, the volume of resources to be invested, and the need to act at different scales to induce changes. The territory, insofar as it makes it possible to innovate and increase the actors' control over transformations, is an essential link in designing and experimenting with new forms of intervention adapted to each situation. And because it connects public and collective actions, it is also ideally placed to link local, national and international actions and to play a primary role in a multiscalar engineering of sustainable development.

Thinking about territories and their place today and tomorrow in the processes of change and of development has to be done in a long-term perspective. Only then can we expect to build a different future together, locally as well as globally. For this reason, foresight approaches must help us to project territories in various evolutionary trajectories to use 'the future to change the present to change the future' according to the catchy formula of Sourisseau *et al.* in Chapter 37. After a period of circumvention of the State and given the challenge of rehabilitating public action, what is taking place is nothing less than a reappropriation of territories – and thus of their own destinies – by the actors, including in political construction at more encompassing levels, especially at the national level. Building on the regulatory role of the territories is a promising way to ensure coherence and peace, i.e., to progress towards sustainable development. The rediscovery of the local and its mobilization to reconstruct the global, to remake the world, is a political project.

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What resources underpin the development of a territory? What does territorial management of resources mean? What specific characteristics and opportunities does territorial organization offer for agricultural production, regulation of sectors, and services? How are territorial public policies conceived and applied? But also, what are the limits of the territorial approach? How does a territorial approach refashion the frameworks of intervention for development? How do we implement and reinvent mechanisms to provide support, build skills, and promote production and good governance? How do we mobilize information systems, apprehend territorial dynamics, and encourage decentralized planning?

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The book brings together the experiences and views of more than 150 researchers and experts from CIRAD, AFD and their partners. It is aimed at researchers, engineers, professionals in the countries of the Global South, as well as students and the wider public.

Patrick Caron, geographer at Cirad, is currently chairperson of the steering committee of the High Level Panel of Experts on Food Security and Nutrition (HLPE) and of the Scientific Council of AgroParisTech. He is a specialist in livestock systems and territorial dynamics.

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